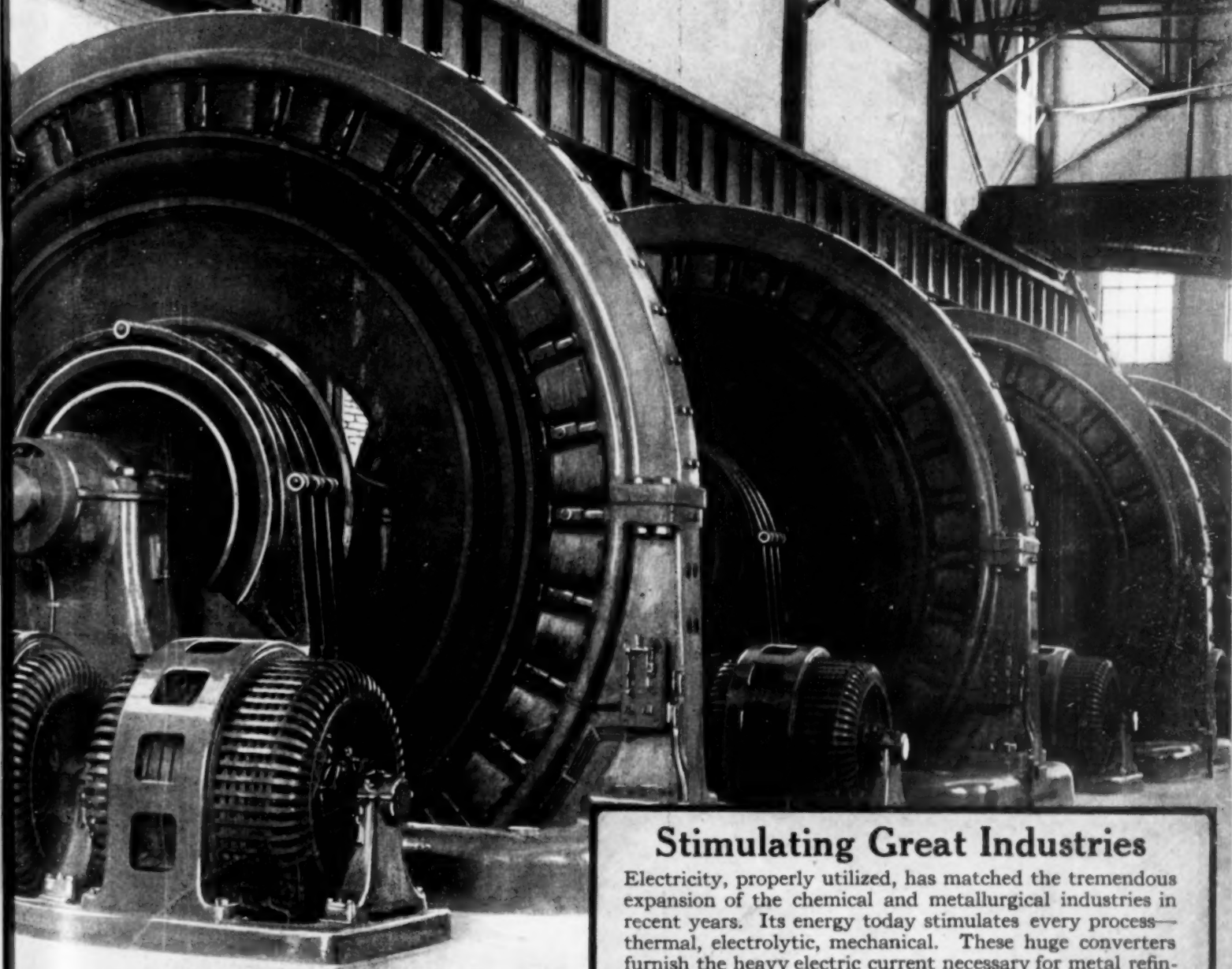


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Chemical Engineers Visit the South

NEW ORLEANS and Louisiana played host to the American Institute of Chemical Engineers Dec. 6 to 9 and carried off their part delightfully, sustaining their reputation for unbounded hospitality and courtesy to the stranger within their gates. There are but four men in Louisiana who boast membership in the Institute, and while it was to their efforts primarily that the success of the meeting was due, they were loyally supported by city and state authorities, local chambers of commerce in the different towns visited, and railroad authorities who co-operated in making the Institute's path comfortable. On the whole it is doubtful if the Institute has had a more agreeable and successful winter meeting. Louisiana's three S's, salt, sulphur and sugar, were objects of more than ordinary interest. Methods of producing the first two are unique in the recovery of those minerals from beneath the earth's surface, while in the case of the second we have an example of the daring ingenuity and vision of a chemical engineer who succeeded in exploiting the deposit after two failures had been made.

The Institute does well to plan its semi-annual meetings in such a way that acquaintance and sociability are promoted simultaneously with the dissemination of technical knowledge and a study of natural resources and chemical industries. A week or ten days of travel, more than any other feature of a technical meeting, is conducive to the making of acquaintances and friends. It relieves the monotony of sessions for the reading and discussion of technical papers and affords the best opportunity for education through observation and contact. From all these points of view the recent meeting in Louisiana was a marked success.

Enter the Physicist Into Industrial Research

A PROMINENT chemical company has recently appointed a physicist as a member of its research organization. Numerous other large industrial concerns are recognizing this variety of scientist with increasing frequency of late. The reason for this industrial appreciation of workers in our related science is not hard to determine. There is in the present tendency not only encouragement for physicists but also a note of warning for chemists.

A well-planned collegiate course of chemical instruction includes physical chemistry and numerous of its important variations, such as thermal chemistry, electrochemistry, photochemistry, etc. However, very often the student completing even the well-balanced curriculum has passed over much too lightly the fundamentals of physics. Frequently it is quite true, as is strikingly remarked, that "the chemist is a man who takes bad physical measurements on pure substances;

whereas the physicist makes wonderful physical measurements of the properties of impure materials." This situation was an early contributing reason for the development of a border field known as physical chemistry. However, even a thorough cultivation of this field is not enough, for fundamental physics must be studied and used by every well-trained chemist.

There will continue to be an increasing number of physicists employed by industry and all chemists can rejoice in this recognition of related science, but for many years to come a vast majority of our research organizations will probably not afford this "high-church form of scientist." It behooves the chemist, therefore, in building his research organization to make sure that some at least of his investigators are capable of caring for the purely physical problems with which any group of investigators is inevitably confronted. This, like many other factors, is simply one of the important things to take into account in planning a research organization. And incidentally, one may add, research organizations will succeed only when well planned; they are not much good if allowed to become a *Topsy*, who "just grewed."

Obstacles to Dye Legislation

DESPITE the serious situation facing the domestic dye industry and the fact that an overwhelming majority in each house of Congress is ready to vote for the dye bill in substantially its present form, it is becoming increasingly apparent that a small minority has an excellent chance of preventing the passage of the measure at this session of Congress. Representatives of the dye industry now in Washington declare that failure to obtain this legislation will drive to the wall all but the very largest concerns engaged in the manufacture of dyes.

Senator MOSES of New Hampshire is regarded as the chief obstacle in the path of this legislation. He is credited with reflecting the views of certain manufacturers of textiles, but it is known that fully 50 per cent of the textile manufacturers favor the passage of legislation which will insure the continuity of the domestic dye industry. Nevertheless Senator MOSES is understood to be ready to direct a filibuster against the measure.

The chief claim of the opposition is that the bill plays into the hands of two large corporations engaged in the manufacture of dyes. Apparently no note is being taken of the signed statements submitted by sixty-four small manufacturers, stating that the bill is more in the interest of the small than of the large manufacturer.

At the short session of Congress the amount of legislation which can be handled, in addition to the appropriation bills, is limited. The appropriation bills have right of way. With a large number of other bills of

great importance before Congress there is much opposition to the consideration of any measure which is likely to develop a filibuster, thus consuming a great deal of the precious time not occupied by the appropriation bills.

The program is to pass a peace resolution as one of the first acts in the extra session. This will automatically abolish the War Trade Section of the State Department and will remove the control which that organization has been exercising over imports of dyes. The War Trade Section has been limiting imports to dyes not made in this country or to those not made in sufficient quantity. Germany anticipates the lapsing of the license system prior to the enactment of an embargo measure and already is prepared to take full advantage of the situation by moving in a short interval large stores of dyes into this country. Friends of the dye industry and advocates of industrial independence for this country should use all legitimate means to secure legal legislation which will enable us to hold the advantages already gained.

Significance of

Price Declines

IT IS a very important fact that Bradstreet's index number stood at 13.6263 on the first day of this month. The index number is a weighted average of commodity prices at wholesale. It is regarded by business men as properly planned and correctly carried out, so that it is really indicative of what it purports to represent.

To make the number 13.6263 more interesting it may be mentioned that the number at the beginning of last February was 20.8690, while the average in the ten years 1904 to 1913 was 8.59637. The number of Feb. 1 marked the high point. It was 142.8 per cent above the ten-year pre-war average, while the number on the first of this month was only 58.5 per cent above. From Feb. 1 to Dec. 1 there was a decline of 34.7 per cent.

This subject of prices is of universal interest. Everyone has to spend money for commodities and is thus directly interested, while many have to purchase services and there is some relation between prices of services and prices of commodities. Those who sell goods are necessarily interested in the general average of prices.

Of the general public the number of men who will endeavor to explain away Bradstreet's index number of Dec. 1 is exceeded only by the number who will pay no attention to it, yet it is an important fact and an illuminating one when properly studied. To explain it away some men will drop into the latest vernacular and say, "But it don't mean anything," because the average man doesn't buy "hides and leather" or "textiles" or "naval stores," which have shown particularly great declines in the past ten months. The real point is that the index number is of wholesale prices and the declines have not all worked out in retail prices. That means simply that they will. Other men will say that some of the low prices of Dec. 1 are due to the existence of unwieldy stocks, that goods are being sold at "a loss" or at "less than cost of duplication," as if the cost of duplication could be known when production costs are declining.

At one time we had the "ascending spiral" and now we have the descending spiral. One decline will bring on another. Declines in prices at wholesale have not fully worked out in declines at retail, whereas the latter should be the greater, as unusual profits had been

added. With reduced cost of living, wages can be reduced and manufacturing costs will decline.

There has been much talk and little study of "pre-war prices." Plot them, or even look at them, using Bradstreet's as a criterion. There is no pre-war "level" at all, but a sinuous line trending upward from 1896 as a low point in all the time since 1892. There were fluctuations before the war, why not after the war? It was as foolish to assert that prices were going to stay at a certain level as to pretend that they ever had stayed at any other level. There was, in fact, a fairly steady rise from 1896 to 1913. There were short "off" periods, of which 1908-9 and 1911 were good samples. While the ten-year average 1904 to 1913 inclusive was 8.59637, the highest yearly average was for 1913, 9.2115. Naturally we are thinking of 1921. That is eight years ahead of 1913, and going eight years back of 1913 we find 1905, a normal year in its time, with an average of 8.0988. Carrying the progression forward, by adding to 1913 the difference between 1905 and 1913 we have 9.2115. To get to that level would come nearer getting to "normal" than getting back to any of the numbers actually recorded before the war, but to get to 9.2115 from the present 13.6263 would be going down only 32 per cent. After all, then, there is not much to quarrel about.

Locking the

Barn Too Late

THE horse was stolen recently, and although perhaps in general circles there was not as much commotion as if Man o' War had been led away by thieves, yet in the ceramic industry there has been almost equal disturbance. We refer to the case of the resignation of A. V. BLEININGER from his position as ceramic engineer of the staff of the Bureau of Standards to go into commercial work. This resignation had barely been announced when the most vigorous protests from many sources reached the bureau. It is evident that the ceramic industry as a whole had thoroughly appreciated the value to it of the service which had been rendered by Dr. BLEININGER's organization, and it is also evident that the industry is now much disturbed that he will no longer be available to serve it thus.

Running all through these protests to the bureau is the thought that Dr. BLEININGER could not have been expected to stay under the conditions of inadequate salary both for himself and for his staff. For a long time it has been well known that his work was most disheartening because of the frequent resignations of his more valuable assistants, usually just as they were getting thoroughly acquainted with the work and becoming increasingly valuable to the bureau in its investigations. And yet nothing, or virtually nothing, had been done about it until after conditions got so bad that Dr. BLEININGER found it necessary to resign.

There is a little consolation in the fact that Dr. BLEININGER has left nominally for a single year and that the bureau hopes to have him resume his work in direction of the ceramic investigations at the end of this period. However confident the industry may feel that it will be possible for him to take up the work again at that time, it cannot look with equanimity upon a whole year of delay in this important field.

This is only one of the many cases where valuable scientific investigators much needed in their present official position by the industries are in danger of extreme discouragement leading to separation from the

service. Other industries which find Government activity as valuable and as diplomatically handled as that which has been directed by Dr. BLEININGER may find it wise to investigate the situation in Washington and see if they too are not in danger of losing that service upon which they perhaps now depend more than they realize. An insistence upon retention of work of this sort upon a high plane with properly compensated chiefs and assistants not only will insure continuance of the work but also will safeguard against the dangers of petty administration and unsympathetic or actually antagonistic governmental attitude toward industrial technology. It would be well if more industries bought a new lock to secure their barn door.

Absurd Chemical Consolidation Ideas

RECENTLY one of the members of Congress made what was to him an amazing discovery that thirty-five different Government bureaus or commissions were doing chemical work or employed chemists. As a result this worthy legislator would revise our Government organization post haste, consolidate all chemical activities in one bureau, and thereby, to his mind, eliminate duplication, increase efficiency and reduce greatly the necessary Government expenditures for this scientific service.

The worthy legislator was probably conservative in stating that at least thirty-five different Government organizations do chemical work. In fact, in making this estimate he probably overlooked a number of them. But he certainly overlooked another factor in the matter much more pertinent than those which have occurred to him. Chemistry is in many instances the servant of industry, and in the Government department it is correspondingly the servant. The Geological Survey employs chemists; so, also, does the Bureau of Mines, the Bureau of Standards and the Bureau of Chemistry. However, no one who knows anything of the work of these four typical institutions would expect the Survey chemists, who are experts in mineral analysis, to care successfully for the food and drug problems of the Bureau of Chemistry, or the paint investigations at the Bureau of Standards, or the gasoline studies of the Bureau of Mines. The chemist has become better known industrially and in the halls of our legislatures during recent years than almost any other kind of scientist, but the education of the public and our Congressmen is still far from complete. No opportunity can be lost to make it clear that the term "chemist" is a generic word including many classes and varieties of workers. All of them have a common interest and use somewhat similar methods. But each in his sphere is a specialist, invaluable there, perhaps, but probably of relatively less value in any other field.

Chemists themselves are sometimes prone to forget these facts. They seem willing to rush into any variety of chemistry whether they are experienced or capable therein or not. It is not strange, therefore, that our legislators are disposed to take such stand as that recently exhibited. If the leaders of the profession have influence, however, there is no reason to believe that serious legislation such as that which has been suggested will materialize. We certainly hope it will not, for one might as well say that all typewriting machines must be maintained and used in a single building as to think that all chemists in the Government service could work to advantage through a single bureau.

Chemists

And Cooks

A COUPLE of members of the Chemists' Club were walking along 41st St., New York, and as they approached the entrance of the club, whither they were bound for their lunch, an automobile drew up to the back door of the hotel across the way. The chauffeur stepped down and politely provided an exit for his passenger. "Let's wait a minute," said the older chemist to his colleague. "That is probably the chef of the hotel, arriving for his day's work." Sure enough it was. A well-dressed man with a foreign air touched an electric button, an elevator appeared beyond a door, and the chief cook entered it and disappeared into the depths. It was as it should be. Cooking is a great art, and the hotel is successful. A large measure of its success depends upon its chef, who is, very properly, a man of circumstance. He is entitled to the luxuries and ease which often accompany achievement.

On the other hand, the two chemists walked, which was also good for them, for the exercise was conducive to their health. But in a moment of confidence they admitted to each other as they proceeded to the club dining-room for their 95-cent lunches that neither possessed an automobile. That, too, may also be as it should, because likely as not neither of them needs one. One of them also observed that as things are going now a far more important desideratum than an automobile for a chemist is a job, although the two who were engaged in the observation and comment were not lacking in this respect.

Why should not cooking be a profession anyway? The consulting chemist is always ready to work over a face powder or a toilet soap, and he likes the opportunity, whereas if he is asked to cook a dinner the chances are that he will decline with the semblance of scorn. Now a leading reason for his refusal and scorn is likely to be that he can't do it; that he doesn't know how. He lacks what the bewhiskered foreigner in the luxurious automobile has in abundance, and that is The Art.

Our food chemists measure calories and allocate proteins, hydrocarbons and fats, and provide for the economies of householding, but why shouldn't they provide for the joy of living as well? If a poet writes a ballad that finds its way into popularity and everybody sings it he counts it to his credit. Dishes of appetizing food, on the other hand, seldom bear the names of their creators; they are more frequently named for eminent French statesmen, or for celebrated gourmets. We should like to see the names of our great chemists more frequently rolled off the public tongue. Advertising men charge millions of dollars and grow rich by inducing the public to become familiar with names of purveyors and of the goods they sell. This sort of thing has its value. And it would be good for chemistry. Think of a menu containing such items as Oysters, Ghent, à la Baekeland; Potage Vitamines à la Mendel; Scrod à la Theodore W. Richards; Prairie Hen à la W. A. Noyes; Salade Mathématique, Langmuir, prepared with Huile Baskerville and Vinaigre Whitaker; Gâteaux à sucres divers, Hudson.

All of these gentlemen have the mind and the ability to do these things; as for Dr. BAEKELAND, we speak from experience when we say that in the galley of a boat he can produce dishes of supreme merit and that if his preparations were on the market the hotels would bid all sorts of prices for them.

Readers' Views and Comments

Joaquim Bishop, Worker in Platinum

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have noticed that Dr. Smith has very little to say, in his books upon the early history of chemistry in America, about the work of Joaquim Bishop, who was assistant to Robert Hare. Bishop became very familiar with Hare's oxyhydrogen blowpipe and used it in working platinum. In 1873, when I was in the private chemical laboratory of Dr. Thomas M. Drown at 1223 Girard St., Philadelphia, Bishop, then by no means a young man, dressed in the straw hat and cowhide boots of a farmer, with a market basket on his arm containing his week's product of platinum crucibles, came to the city from Sugartown to dispose of his product to Bullock & Crenshaw, whose store was located at Sixth and Arch. He frequently came to our laboratory, in response to a request from Dr. Drown, to get instructions about the manufacture of apparatus of platinum. At that time pieces made of platinum were soldered together with gold. Shortly afterward he reported that he could weld them; gold could be dispensed with. He made some rather intricate pieces for us, without any boasting about his skill, which was very great. He was very plain in manner and speech, rather tall, with a pleasant smile. About 1882 I went up to Catasauqua to see H. J. Seaman, then chemist for the Crane Iron Co., and found him putting a patch on a perforated platinum crucible. His anvil was a railroad spike, welded to fit the inside of the crucible and driven into a wooden block. The crucible he was using had been repaired repeatedly in this way.

EDWARD HART.

Lafayette College,
Easton, Pa.

Steel Rails From Sink-Head and Ordinary Rail Ingots

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read with great interest the series of papers by Dr. George K. Burgess, "Steel Rails From Sink-Head and Ordinary Rail Ingots," appearing in the November issues of CHEMICAL & METALLURGICAL ENGINEERING. Accompanying editorials were also of exceeding interest, especially that appearing in the issue of Nov. 17, "Why Not Turn the Mold Over?"

There is no question that good rails, or any steel product, is more than a sulphur print, and that Service is the final analysis by which quality must be judged.

The comparative method of conducting the Hadfield and Maryland ingot tests I feel is, however, open to just criticisms in that: First, a similar chemical analysis of steel was not employed. Second, that the more homogeneous and consequently denser Hadfield ingots were rolled in the same number of passes (thirteen) employed in blooming the more open and less dense Maryland ingots. It has been the experience in very many plants which have adopted the turned over, or big-end-up, mold method of producing ingots that the denser steel cannot be reduced in cross-section as rapidly as the more open, less dense ingot, without danger of producing cracks or internal ruptures in the more dense material. Third, that the Hadfield ingots were charged in the soaking or reheating pit cold,

which enhances the liability to surface defects and deep cracks most materially. The relatively large number of "second" rails from the sink-head ingots is unquestionably attributable to this practice of cold charging and heavy blooming passes of the Hadfield ingots.

The exhaustive tests of the Bureau of Standards, as described by Dr. Burgess, have clearly proved beyond peradventure that no physical defects and chemical segregation less than 12 per cent can be assured to the producer and buyer of steel product for at least 85 per cent of the weight of the ingot, whereas in the ordinary type of ingot production, even after cropping 26 per cent from the top of the ingot, defects are apt to occur in the middle and bottom portions of the ingot and in the finished product produced therefrom. I wish to reiterate that faulty heating and blooming of rails and other products can spoil or reduce the quality and homogeneous structure of initially perfectly sound homogeneous steel ingots, and that those who undertake to remedy the present defects in rails and other steel products must look further than the obtaining of an initially sound ingot, although that is the primary requisite. Care in reheating and in employing a suitable number of blooming passes has been found absolutely essential in order that the producer of sound ingots may profit thereby in his finished product.

Gathmann Engineering Co.,
Baltimore, Md.

EMIL GATHMANN.

Electric Furnace Refractories

To the Editor of Chemical & Metallurgical Engineering

SIR:—A reply to the letter written by Robert D. Pike, criticizing certain statements made by the writer in the article entitled "Electric Furnace Refractories," and published in your issue of Dec. 15, may be in order.

Particular exception was taken to the statement in that article that amorphous magnesite was entirely unsuited for the manufacture of refractories. The writer still maintains that the statement is correct and will be borne out by anybody and everybody who has had a wide experience in the manufacture and sale of magnesite refractories made from the raw material from Washington, California, Austria, Greece and Venezuela. It will be noted that the statement was not made that refractories *could not* be made from the amorphous type, but that it was *unsuitable*.

After the Austrian magnesite was cut off by the war this country was driven to the use of the amorphous magnesite of California. No one but the manufacturers themselves will ever realize the amount of effort, time and money that was put forth in an effort to make a product satisfactory to the steel and copper industry from this material. Four years of research and experimental work, combined with the erection of special plants and the installation of special equipment, did not solve the problem and convinced both producers and consumers alike that a satisfactory product could not be made. Furthermore, as soon as refractories made from the crystalline ore became available the consumers refused to purchase those made from amorphous ore.

Mr. Pike is quite right in his statement that the formation of periclase or beta magnesite has nothing to

do with the type of magnesite used. However, the formation of periclase was the stumbling block to the successful use of the amorphous type. Periclase is more readily formed with the crystalline type and the formation begins at lower temperatures. Brick and shapes made from the crystalline can be thoroughly converted to the periclase stage in the kiln before they start to squat or soften out of shape, reaching a point of complete crystallization in perfect condition. When the amorphous is used, however, the formation of periclase does not take place until the critical point is reached, and any attempt to reach a point of complete conversion resulted in losses that the manufacturer could not stand on quantity production. The firing of the product was, therefore, stopped before the critical point was reached and while the magnesite was still in the amorphous stage and an unsatisfactory product resulted.

Mr. Pike is not correct in his statement that the Northwest Co. was the first in the United States to build and operate a plant which produced a true dead-burned magnesite. In 1915 the American Refractories Co. started the first dead-burning plant in this country at Harper, Ohio. Later the Lehigh Portland Cement Co. converted a portland cement plant at Coplay, Pa., and operated it as a dead-burning plant. Following this the Harbison-Walker Refractories Co. constructed and operated a dead-burning plant at Chester, Pa. All of these plants produced true dead-burned magnesite from California amorphous magnesite and all were constructed and operated before the Northwest plant at Chewelah, Wash., was built. It might be added that these plants produced material of the highest possible grade from the material used and were operated by men recognized as being the foremost in the industry.

The real reason for the production of only calcined magnesite instead of dead-burned in California was that there was not and is not any single deposit in California large enough to warrant the establishment of a dead-burning plant, and so long as it was necessary to ship the material from several points, the refractories manufacturers preferred to convert existing rotary kiln plants in the East to dead-burning plants or to add rotary kiln equipment to their brick plants. The magnesite was calcined in California before shipment East in order to save freight, as it loses practically half its weight through the driving off of the CO₂ gas. California magnesite was not "dead-burned," therefore, simply because the users preferred it otherwise and there was never a time when the magnesite manufacturers, or for that matter the ultimate consumers, were confused over the terms "calcined" and "dead-burned."

It is useless to enter into any argument over the relative merits of Austrian and American magnesite. It is quite sufficient to say that in spite of the fact that a considerable tonnage of Austrian has been coming into this country regularly for the past two years, the supply has never equaled the demand and the cargoes have always been sold before reaching this country.

Pittsburgh, Pa.

A. F. GREAVES-WALKER.

A Substitute for Cork

It is reported that a Czechoslovakian chemical works at Brünn has treated turf by a special patented process whereby was furnished a material for insulation and building purposes that is said to be, in most respects, not inferior, and in some superior, to cork. The product is reported to be light, firm and soundproof, to possess great insulating properties, and to be damp-proof.

Kauri-Gum Industry in New Zealand

The kauri-gum industry, which has been an important factor in and around Auckland for the past half century, is taking on new impetus since the closing of the war, reports Consul General Winslow, of Auckland. In the past most of the work was done by hand and by individuals, something like gold was mined years ago in new fields, with the result that the top had only been skimmed over and the better pockets dug out. These methods have secured about \$100,000,000 of kauri gum to date, and it is claimed that there is still left in the kauri field gum and byproducts worth at least two or three times what has been taken out.

GOVERNMENT ENCOURAGEMENT FOR INDUSTRY

Until recently the development of the kauri-gum fields has been left entirely to private enterprise, but about three years ago the New Zealand Government established a department for the supervision and encouragement of the industry, with the result that more extensive operations are being undertaken by companies as well as by individuals. It is now proposed to develop the industry along more systematic and scientific lines than those heretofore employed.

From 12,000 to 15,000 tons of kauri gum will, it is expected, be produced per annum, instead of 8,000 or 9,000 tons, as was the case previous to the war, to say nothing of the byproducts, which are estimated to be worth as much as or more than the gum itself. One company plans an output of 8,000 to 9,000 tons of gum per annum, and there are besides many private individuals at work in different sections of the field, and other interests are contemplating putting in new up-to-date plants.

SLUICE MINING—EXTENT OF FIELDS

The latest undertaking is to mechanically gather the gum from the peat, or pukau, which is really the damaged kauri gum, in the low or swampy land found in the territory around Auckland. This is to be worked by what is known as the sluice process, similar to sluicing for gold. The peat is placed on a screen and water is forced through it. The screen gathers the chip gum and allows the waste or tailings to drop beneath. This chipped gum is divided into about 15 per cent first quality, 15 per cent second quality and 70 per cent low grade. The tailings are converted into kauri-gum oil in a manner similar to extracting oil from shale. It is estimated that 40 to 50 gal. of kauri-gum oil can be taken from a cubic yard of pukau. This oil is a very valuable commercial oil, containing a large percentage of motor spirit and turpentine.

It is stated that one company in Auckland has control of kauri-gum rights covering 47,000 acres, estimated to contain 13,000,000 cu.yd. of pukau. In addition, the New Zealand Government still holds kauri-gum reservations that are estimated to contain an even larger quantity of pukau, to say nothing of many private interests holding small sections of kauri swamps. This will give some idea of the real size of the industry that means so much to the paint and varnish interests of the United States, as well as to the linoleum and rubber manufacturers.

The New Zealand Government is allowing persons to stake out tracts or claims of three acres on the government reservations, for which the individual operators must pay 10 per cent of the value of the gum taken from these swamps.



HISTORIC JACKSON SQUARE. OLD SPANISH CABILDO AT RIGHT

The New Orleans Meeting of the American Institute of Chemical Engineers

Report of the 13th Winter Meeting, Reviewing Salient Features of Papers Presented, With Notes on Excursions to the Union Sulphur Plant at Sulphur, the Salt Mines at New Iberia and the Luray Cavern

THE thirteenth winter meeting of the American Institute of Chemical Engineers took place at New Orleans, Dec. 5 to 9. The paper program was held in the ancient Cabildo. This is a dignified two-story structure of adobe and shell lime, which has stood since 1795 as a monument of Spanish dominion over the Louisiana territory. Not far distant Audubon Park marks the place where, during this same memorable year, Etienne de Boré made the first plantation sugar. Eventually this was to become the primary product of the district and exerted no small influence in bringing about the Louisiana purchase eight years thence by the United States. President David Wesson in the opening address told what the Institute has been, is and should be by starting off with one of his appropriate stories.

PRESIDENTIAL ADDRESS

"In the good old days of long ago, when every man of standing in this part of the country had his special body servant, two colored boys were heard discussing their respective masters. The first was bragging about the great wealth his master, who was a rich planter, had accumulated. He ended by saying 'Your boss is always traveling. Don't you know a rolling stone gathers no moss?' the answer came back quick as a flash, 'It sure doesn't get any moss, but it gets lots of polish just the same, and that it what your boss needs.'

"This remark applies in some respects to the Insti-

tute. When we take an excursion like the present one, the railroads remove considerable of our moss, but the inspiration and broadening effect caused by close association with many master minds of our profession engaged in the various fields of industry more than compensate for the time and lucre spent in attending this meeting.

"One of the first objects of the Institute was to bring men together who had made good in their profession, so all might be benefited by mutual interchange of views.

"Another object was the elevation of the profession to a position in the community commensurate with the services of its members.

"Up to a year ago the Institute passed through a slow but steady growth. The high code of ethics and the standing of its members gave it a respected place, but there were not enough of us to do properly the work for which we seemed to be especially fitted.

"Some of our far-seeing members suggested that the Institute would carry more weight in important national affairs if the membership contained all those who were eligible. A modest campaign was started with the result that our total membership today numbers 454 as against 365 of a year ago, an increase of 24 per cent.

"During the past year we have joined the Federated American Engineering Societies, whose object is to secure the co-operation of the prominent engineering societies of the country to utilize their possibilities for constructive work in great public service questions, in

matters of transportation, conservation of natural resources and similar affairs.

"We have given hearty support to the proposed reorganization of the Department of Interior into a Department of Public Works.

"The Institute is backing the compilation of the Compendium of Critical Chemical and Physical Constants, which when completed will furnish a valuable storehouse of information and become a needed tool chest for members of the profession.

"The Institute is also acting to some extent in an advisory capacity to the Government engineers having in charge the survey for the new Boston-Washington superpower project.

"These facts are mentioned to show that at the present time the Institute is not merely a joy ride association, but its activities are of national importance.

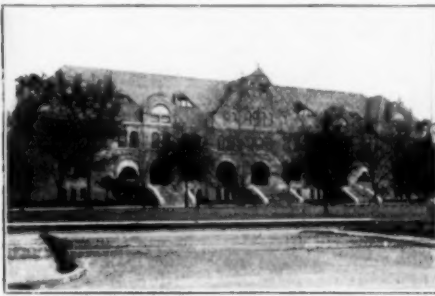
"There is no longer any question of the value of the work of the chemical engineers to the welfare of the country. There is, however, the great question as to how it can be made of greater value. We have all seen what organized labor has done through the sheer strength of numbers and organization. Is it asking too

ing, as far as emphasis is concerned, though as a producer or a manager of chemical production he is older than some of these, though not in an organized way. The chemical producer of the nineteenth century was unorganized. His only approach to solidarity came through chemical societies. These were naturally academic and looked down upon the chemical engineer as an empiricist who was neither an engineer nor a chemist. The mechanical engineer felt that he could do all the engineering necessary in chemical manufacturing. On the other hand few chemists connected with manufacturing could resist the temptation to call themselves chemical engineers, though their work was entirely analytical control or industrial research, and though they did not have to deliver the production or put up or operate the equipment. The chemical engineer can do and often does the strictly chemical things too, but on the other hand not all that do this important control and investigational work are engineers.

"The American Institute of Chemical Engineers has played an important part in clearing the atmosphere about what constitutes a chemical engineer. To the speaker's mind all is not as clear as it might be even



AUDUBON PARK



MAIN BUILDING, TULANE UNIVERSITY



CLOISTER ALLEY

much to have all those who are fitted by education, achievement and high character brought into one strong organization by becoming members of our Institute? With the professional leaders of our chemical industries all working together toward one common end, an enormous influence for good can be exerted upon the material, economic, educational, legislative and industrial affairs of the country. The days have gone by when the Institute was regarded by some as a sort of excursion club for a select few. The day has come when the Institute must take the lead in shaping the thought of the chemical industries of the country, and to do this, it should count among its members all the qualified leaders of those industries. During the past year we have made a fine start. Let us, therefore, keep up the good work of securing desirable members so we may better accomplish the work which lies before us."

THE A.I.C.E. AND THE F.A.E.S.

Prof. James R. Withrow gave a report on the Washington meeting of the Federated American Engineering Societies, which need not be abstracted here, as a full report has been presented in our issue of Dec. 1. His views on the chemical engineer among engineers are reproduced as being of salient interest.

"The American Institute of Chemical Engineers is an organized effort to represent the solidarity of the profession of chemical engineering. The chemical engineer occupied a peculiar position in the engineering profession. His branch is new compared to the others such as civil, mechanical, and even electrical engineer-

ing, as far as emphasis is concerned, though as a producer or a manager of chemical production he is older than some of these, though not in an organized way. The chemical producer of the nineteenth century was unorganized. His only approach to solidarity came through chemical societies. These were naturally academic and looked down upon the chemical engineer as an empiricist who was neither an engineer nor a chemist. The mechanical engineer felt that he could do all the engineering necessary in chemical manufacturing. On the other hand few chemists connected with manufacturing could resist the temptation to call themselves chemical engineers, though their work was entirely analytical control or industrial research, and though they did not have to deliver the production or put up or operate the equipment. The chemical engineer can do and often does the strictly chemical things too, but on the other hand not all that do this important control and investigational work are engineers.

"However, with this good work done or in progress, it is our part to go steadily forward in assuming the responsibilities of an engineering organization. It was quite natural, perhaps, that during the war the larger group of chemical men, the American Chemical Society, were mistaken by the other engineering societies as their chemical complement. The American Chemical Society should have been taken into all that it was taken into, but the great bulk of its members are not interested in chemical engineering. This Institute should not have been omitted, however. Repeatedly I have had to protest in this matter. Now it would be the Naval Consulting Board, again it would be the National Research Council, again the Joint Conference Committee. Others have interested themselves in this also, to my knowledge. Sometimes I have notified the Institute of my protests and sometimes I have not.

"It is our duty to stress less the chemical and more the engineering. The words of our name make this clearly necessary. Chemical engineering is *engineering*. It is the engineering of chemical productions—not the chemistry of chemical production. That is industrial chemistry—and is *chemistry*, and by no means engineering, though chemical engineering is its handmaiden.

"It is our duty also to weave our web closer and closer to the other branches of the engineering profession. It is here that our future lies. We have at once the most difficult, the most enthralling and the most undeveloped field of the whole profession of engineering.

"Since it is our duty to align ourselves more and more with the engineering profession, our question is, Where shall we begin so as to be of greatest assistance to the engineering profession as a whole, and make the other engineering profession branches respect the dignity of our field? My purpose is to emphasize that we have taken our rightful place as an Institute of Chemical Engineers by joining hands in the public service for America's good, with the other engineering associations in the Federated American Engineering Societies."

ASSOCIATE MEMBERSHIP DISCUSSED

Frank E. Dodge introduced a resolution creating associate membership, which is believed to be more desirable than the present junior grade. No action was taken, and after considerable discussion the motion was tabled to allow time for general opinion to crystallize. Many manufacturing plant mechanical engineers having allied chemical interests and accomplishments are to be included in this class if it is worked out on the tentative basis discussed at the meeting.

LONGWORTH DYE BILL INDORSED

Recognizing the conflicting opinions in Congress toward protecting the dye industry, the Longworth bill was briefly indorsed and the following resolution wired to Washington:

Whereas the American Institute of Chemical Engineers, at the annual meeting at New Orleans, now in session, recognizing the importance of the coal-tar industry to the country at large and the great danger threatening it in case adequate protection is not afforded it by our Government before peace with Germany is declared; therefore be it

Resolved, That we reiterate the position taken at our annual meeting in Savannah in December, 1919, and urge immediate favorable action on the so-called Longworth bill.

SECTION 9 OF NOLAN BILL CONDEMNED

The rider in the Nolan bill, Section 9 of H.R. 11,984, which may be found in our issue of Oct. 27, was condemned as being improper legislation. It was thought that the rider would lead to interference by the Government bureaus with business enterprise with which they were originally intended to co-operate in supplying service of benefit to all.

WELFARE PLANS OF THE DU PONT COMPANY

Charles L. Reese gave an interesting account of the present plans of the du Pont company in protecting the savings of employees with stock investments in the company as well as the presentation of awards of stock for extra compensation whenever merited. During the war some of the employees received an annual bonus as high as from \$30,000 to \$50,000. Invention, bravery, valuable suggestions were all compensated for in adequate manner. Regularity and continuous employment are not overlooked in the stock awards. The complete details will be published in an early issue.

CONSERVATION OF HEAT LOSSES

E. R. Weidlein described the development work done for the Magnesia Association at the Mellon Institute. Calculation charts were given with which the most economical installations are found. When it is considered

that the energy losses of 100 ft. 6-in. uncovered pipe at 100 lb. pressure are about equivalent to 300 tons of coal per year on an average, the importance of 85 per cent magnesia needs no further comment. In discussion Henry Howard recommended combination with felt for low-temperature insulation when condensed moisture would remove the insulating air cells in the usual magnesia insulation. Roofing paper should be applied as protection against water and should not be allowed to become hot, else the flux oils saturate and ruin the insulation.

RECENT ADVANCES IN THE SULPHUR INDUSTRY

In the absence of Dr. Raymond F. Bacon, the paper on sulphur was read by Dr. Weidlein. Two new sulphur domes have been operating recently in Texas, with the result that the supplies of sulphur have been adequate to supply every demand at prices actually competitive with pyrites. Dr. Bacon believes that sulphur should be used as an engineering material, as it has many desirable properties not obtainable readily elsewhere. It can be filled with sand to lower the volume cost. Acidproof conduits have been produced at an extremely low cost from sulphur.

THE SULPHURIC ACID FUME PROBLEM

This was a preliminary paper by Drs. James R. Withrow and F. C. Vilbrandt on their investigation on acid fumes. The literature and legislation were reviewed and the various analytical methods of testing contaminated air critically examined. The permanganate method was found unreliable due to the fact that intermediate reduction products of colloidal manganese oxides were produced. Standard SO_2 mixes were also found unsatisfactory, due to this vapor not forming stable mixtures under all mechanical conditions. For instance, passage through an abrupt angle caused considerable variation in the composition of the air-vapor mixture.

COST ACCOUNTING

Successful plant operation depends on proper interpretation and analysis of costs. A. G. Peterkin presented the manager's point of view. He wants less routine reports and masses of burdensome statistics on costs, with the result that the accounting department will be free enough from routine labor to work up any data upon request at any time. The basic fundamentals on cost keeping were presented, the details of which will be published in a subsequent issue.

SUGAR AND MOLASSES

Lezin A. Becnel presented some interesting charts on cane products showing the relationship between molasses and sugar production. He was very much in favor of less sugar extraction and the consequent production of higher quality sirup byproducts. The price of the latter will be more than sufficient to compensate for the sugar remnant, when compared with the present grades of lesser epicurean virtues.

RESOURCES OF LOUISIANA

A rich soil abundantly irrigated by the waters of the alluvial Mississippi is Louisiana's greatest asset. N. L. Alexander, chief of the State Conservation Commission, gave an illustrated lecture describing the forest and game reserves of the state. About 200,000,000 ft. of lumber is cut annually by the 460 sawmills within the state. Reforestation is rapidly becoming necessary and

anticipating this the state has established a 30,000-acre reservation. Pulpwood of good kraft quality has been produced in fifteen years. The Goodyear Co. is planning to plant an extensive reserve to supply its pulp mills in the near future. Tax reductions are being offered to induce forest planting and lower the investment required. Boys' clubs appear to be especially promising in this direction. The game reserves far outstrip the combined zoos of the world. Ducks, geese and all waterfowl from the entire North American continent appear to appreciate the natural advantages of the state during the winter season.

Sulphur, salt, gas and petroleum have been found in quantity. The two former will be described later. Considerable alarm is felt over the rapid growth in the state of the carbon black industry, which will rapidly exhaust the gas fields and yield very small return to the welfare of the state compared to household consumption. The present law requires all new installations to obtain a state permit, which will be granted in fields located in places remote from towns and cities.

WATER PURIFICATION, SEWAGE AND DRAINAGE

George G. Earle, the engineer who has freed the Crescent City of the difficulties incident to the negative elevation of the city, described the pumping system used to empty the seepage, sewage and rain waters over the levees into the river. Special pumps were designed based on the screw effect which will pass almost any obstruction from an overcoat to a demijohn.

HANDLING CONCRETE MIXES

On large construction work the mixer is usually located as centrally as possible and to facilitate the handling of the mix, a very wet mix is used. Maximilian Toch drew attention to the danger of defective construction due to this and advocated that the engineering profession undertake to improve the present practice. He was not prepared to offer suggestions, but hoped to be able to do so in the immediate future.

ACTIVATED SLUDGE

Edward Bartow gave an interesting lecture on the treatment of sewage by aëration in the presence of activated sludge as developed in England. The greatest problem requiring solution appears to be an economical method of drying the sludge. This contains 90-odd per cent of water, which is removed with difficulty on the scale required. Experiments are now under way that may lead to results at Milwaukee. Where a large area of open country is available and the climate is dry, solar evaporation offers about the most satisfactory way around the drying difficulty.

SALVAGING SAG PASTE

Sag paste is the zinc oxide ointment used during the war as a skin protector against poison gas. C. B. Morey described the method used by the Larkin Co. in salvaging the fatty constituents and the tin in the container tubes. Several million tubes were worked up into merchantable products, the operations for which were of interest due to the way the problems encountered were solved.

DATA ON HORIZONTAL TUBE EVAPORATION

Results on evaporation data are hard to get, due to the multitude of variable factors. Prof. W. L. Badger presented his fourth report in which he worked on

distilled water in a horizontal tube evaporator. The paper will be published in full in an early issue.

VISIT TO UNION SULPHUR PLANT

The Institute Special train arrived at Lake Charles Wednesday morning. The local Chamber of Commerce showed great appreciation of the talents of chemical engineers, undoubtedly being influenced by the accomplishments in their locality of the late Herman Frasch, and not only were prepared to welcome the visitors but banqueted and carried them in their automobiles out to Sulphur, about twelve miles distant.

The area of the sulphur works is about sixty-five acres, studded with derricks similar to an oil field. The great boiler house and multitude of compressed air, hot water and sulphur pipe lines are the distinctive features. The old dome looks more like a lake, due to subsidence of the soil where the millions of tons of sulphur have been removed. Plank roads set on piles interweave through the works. A slight mist of water vapor floats over the ground, but the 750 ft. of earth almost completely hides the presence of the superheated water below.

The blackish-brown molten sulphur is air lifted from the lower levels of the bed into 3,000-gal. open pans, from which it is pumped by centrifugals to the board-framed stock pile.

SALT MINE AT NEW IBERIA

Chemically pure salt is usually obtained only by the aid of chemical technology, but only the arts of the miner are required at the salt domes called Averys, Weeks, etc., islands because of their elevation above the surrounding flood lands. The beds are of Quaternary age. The crystal structure is such that practically all the mother liquor inclusions have drained off to some unknown locality, which when found will probably give the long-looked-for source for potash and magnesium salts.

The ladies of New Iberia were the hosts. The party was driven out to the rice mill, where the grain was hulled, the bran removed and a polish applied by means of a paste of glucose and soapstone. At the present time a large pulp mill is being erected to utilize the cane bagasse and rice straw of the district.

Refreshments were served at the hotel, after which Toastmaster Williamson called up the speakers. Dr. Olsen in his talk did his best to repay the hosts with a liberal supply of expert advice on salt. He told them that while they were receiving about \$4 per ton for the raw salt at the mine, they were paying about \$140 to the North for the manufactured goods made from this ton of salt. The orchestra finally resorted to dance music and the party ended at a late hour with the refrains of "Home, Sweet Home."

NEW YORK PARTY STOPS OVER IN VIRGINIA

The special car Custer was dropped off at Roanoke so that the party could see the city. The blast-furnace plant of the Virginia Iron, Coal & Coke Co. was visited. The Dwight Lloyd process of desulphurizing pyrite ash proved to be the most interesting feature. From 3 to 4 per cent sulphur is present in the ash as it is received from the sulphuric acid works. This is mixed with powdered coal and ignited on a 60-ft. chain belt grate. Excess air is drawn through the mass, which has been leveled to a uniform thickness of 6 in. Practically all the sulphur is oxidized and the quenched iron and coke

clinker is mixed with local brown and Lake Superior ore to give the analysis required for the blast-furnace charge.

The Luray Cavern, with its unique calcite crystals wrought into amphitheatres, towers of Babel, Castles on the Rhine, Saracen's tent, fish market, scarfs, drapery



LURAY CAVERN

and hundreds of artistic forms, was a fitting sequel to the meeting. The underground chemical plants operated by nature at Sulphur and New Iberia could be much more appreciated after the visit to this subterranean museum of fine art.

ATTENDANCE

A. A. Backhaus, Walter L. Badger, William M. Barr, G. E. Barton, Lezin A. Becnel,† Percival C. Brooks, W. E. Burkhard, Harry O. Chute, Charles E. Coates,* Albert Dinwiddie, Frank E. Dodge, W. C. Ermon, A. E. Gibbs, Freeman I. Gibson, John Henning, Robert W. Hilton, Henry Howard, Daniel D. Jackson, Courtenay de Kalb,* Harry W. Kellogg,* Arthur C. Langmuir,* M. P. Landis, Louis J. Matos, John C. Minor, Hugh K. Moore,* C. B. Morey, J. W. O'Brien, John C. Olsen,* Howard C. Parmelee, Albert G. Peterkin, George A. Prochazka,† Charles L. Reese,* A. E. Rice, Wallace Savage, Ralph S. Sherwin, Albert W. Smith,* Kent Smith, W. R. Swint,* Maximilian Toch, Edward R. Weidlein, David Wesson,* Charles S. Williamson,* James R. Withrow, Frederick C. Zeisberg.*

French Factory for the Manufacture of Vaseline

Preparations have been made for the erection of a vaseline factory along the Nievre River at Ile-d'Elle, Department of Vendee, where the existence of a clay rich in alumina has been discovered, reports Consul Moorhead, of Nantes, France. New methods employed will produce vaseline at lower than ordinary prices.

*Accompanied by wife.

†Accompanied by wife and daughter.

Need for Work on Aluminum by Bureau of Mines Pointed Out by Dr. Moore

The Bureau of Mines has requested an appropriation of \$29,920 for work on aluminum. In explaining the need for this work, Dr. R. B. Moore, the bureau's chief chemist, has prepared the following statement:

During the last two or three years the Bureau of Mines has had two men working in aluminum, mainly in connection with aluminum losses in remelting, etc. The small sum available has not made it possible to take up larger phases of the work—namely, the cheap manufacture of aluminum oxide, either in a primary operation or in connection with byproducts, and improvements in the manufacture of aluminum metal itself. Such a line of work will involve a special appropriation which is not now available and will require at least a minimum of \$30,000 to carry out in an efficient manner in so far as the Government is concerned.

Aluminum is one of the most important metals of the present day and its use in the industries and for domestic purposes has only just begun.

In the process of aluminum manufacture, oxide is first produced, the source of the oxide being almost entirely bauxite. By electrolytic methods the oxide is then converted into the metal. Therefore there are two distinct steps involving improvements and efficiency—namely, the production of the oxide and afterward the production of the metal.

At the present time the cheap production of potash from silicate rocks, such as potash, feldspar, leucite, etc., involves aluminum oxide as a byproduct. The possibility of making aluminum oxide from certain types of clays and other aluminum minerals besides bauxite is of extreme importance for the cheap production of aluminum metal. The possibilities of even producing metallic aluminum directly from the aluminum minerals without the intermediate production of the oxide and the after use of electrolytic methods have by no means been entirely exhausted. On the other hand, undoubted improvements could be made in the present electrolytic methods, especially in the way of getting a standardized product.

The use of aluminum has tremendous possibilities in the industries and for domestic purposes. Its alloys with magnesium are receiving at the present time much attention, as such alloys are often even lighter than aluminum.

Duralumin, which is an alloy of aluminum, copper, manganese, etc., is an extremely light alloy but has the strength of mild steel. It has been used by the Germans with great success for a large number of purposes, especially for the framework of dirigibles, for airplanes, etc. The uses of aluminum and its alloys in connection with automobile parts, for domestic purposes, etc., are well known. If the price could be brought down to considerably less than the price at the present time, its uses would be greatly extended.

American Shoes in Switzerland

American shoes are sold in Berne and, in fact, in practically all the larger cities of Switzerland. Imports since the war show an encouraging increase. In that country there are about twenty shoe factories with an output of about 80,000 pairs daily. One factory alone is said to produce 50 per cent of the total output. Because of the development of the industry there is also a comparatively good market for shoe uppers, reports Consul Haynes. The possibility of success would be more probable if stocks were kept in Switzerland, such a system being generally preferred to the presentation of samples. The value of leather imports is about \$4,000,000 annually, the import duty varying, according to quantity and quality of leather, from 77c. to \$4.63 per 100 kilos (220 lb.) gross weight. The duty per 100 kilos is as follows: Sole leather, 16 fr.; box calf, brown, glazed, 24; box calf, black 18; vamp leather, brown or glazed, 10; other upper leathers, 4; other leathers not specified in the tariff, 4 fr.

Ammonia and Benzene Column Stills

Description of Operating Methods of Ammonia and Benzene Column Stills—Action of Steam in Heating and Conveying Vapors—Causes of Trouble and Precautions—Process Control—Recommendations on Liquor Metering

BY A. THAU*

FOR the distillation of ammonia and benzene in connection with the recovery of byproducts from coke ovens, continuous column stills are almost universally employed. The original "Savalle" column, which was the first continuous alcohol still, was adopted at first as a progressive departure from intermittent boiler-type stills. Gradually improvements were introduced to adapt the columns to the particular purposes for which they are applied in coke-oven work, and in recent years they have reached high efficiency, while at the same time their bulk in proportion to their capacity has been considerably decreased.

Designers of these stills were formerly rather reluctant in constructing single units for very large capacities. Experience had shown that if particular care was not taken when heating up the stills, the bottoms or flanges of the sections would crack. This danger increased with the diameter of the still. This accounts for the fact that in old ammonia and benzene plants a large number of small units were used, while on modern works few large ones are used and in most cases only one unit.

The control of a badly performing distilling column has always been considered a difficult task, but if the process taking place inside the still is perfectly understood, it is not difficult to allocate and remedy irregularities.

The Savalle column, the principle of which has been retained completely in subsequent design as shown in the figure, consists of a number of circular or rectangular sections, flanged together. While the liquid to be distilled is being introduced into the top section of the column, steam enters countercurrent at the lowest section near the bottom of the still. The steam is distributed through a number of round holes or rectangular slots *a*, the edges of which project about 2 in. above the bottom plates. These steam passages are covered a short distance above the projecting edges by hood-shaped baffles *b*, which project downward close to the bottom or tray *c*. They are provided with small teeth so as to distribute the steam evenly in a fine spray through the liquid which collects on tray *c* of each section.

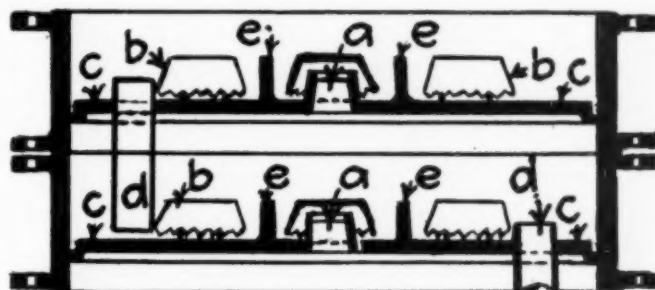
Tubular or rectangular overflows *d* are provided for each section. Their upper edge does not project quite as high as those of the steam passages *a*. They go down into the next lower section so that their end is sealed in the liquid collected on the bottom. Baffle strips *e* are arranged on each bottom *c* between the baffles *b* in order to compel the liquid to flow over each tray and all around the baffles *b*.

By these arrangements the steam is guided upward and the liquid downward through the column in sep-

arate passages. If liquid travels through the steam passages or steam through the overflows, the operation of the still is impaired, though perhaps it is not immediately noticeable. However, before dealing with such occurrences it will be necessary to follow closely the processes performed in each section.

TWOFOLD ACTION OF STEAM

The steam expands and fills the section completely, thereby directly heating the lower layer of the liquid and indirectly the liquid in the section above. The transmission of the heat through a cast-iron plate of about $\frac{1}{2}$ in. in thickness is much slower than by direct contact. Vapors of products with a lower boiling point are volatilized and mix with the steam. In the bottom section, where the liquid should contain only traces of products, this admixture is naturally relatively small, but it increases from section to section upward, while an amount of steam, proportional to the amount of vapors taken up, condenses. This action



is of minor importance compared with the effect resulting from the steam being forced in fine streams from under the baffle edges through the liquid with which it is thus brought into very intimate contact. The transmission of heat from the steam to the liquid is thereby greatly increased and the admixture of light vapors becomes much greater. It is clear that these actions are parallel in each section of the still, one supplementing the other. In the same degree as the steam traveling upward becomes enriched by vapors, the liquid running down becomes spent.

A different way of describing the direct action in a column still can be applied by assuming that the steam, in passing through the indirectly heated liquid, takes up vapors with a lower boiling point in exchange for water vapor which is condensed and dilutes the liquid. Whether this or the other explanation appeals the more is immaterial, as the actions are due to both. The column still can, of course, be used as a washer and some of the first gas washers ever built were constructed on the very same principle. The gas takes the place of the steam and the washing liquid is fed the same way as for distilling. The only differ-

*Superintendent of coke works and chemical plants of the Oxelösund's Iron Works, Oxelösund, Sweden.

ence from distilling rests with the fact that a chemical or mechanical absorbing effect is obtained without the aid of heat. Ammonia, benzene, cyanogen and naphthalene washers of this type are still used. Though they were formerly built of very large diameters with large gas passages and baffle openings, they are now rarely applied as washers owing to the great amount of back pressure they cause, which also impairs their efficiency.

In the construction of the column still two different tendencies are prominent. Many constructors disregard the indirect action of the steam and provide as many passages, baffles and overflows as can be crowded into the column. Others try to make full use of the indirect heating by the steam and arrange only one steam passage, baffle and overflow to each section so that large layers of liquid are collected in each, offering a large surface to the steam above and underneath. In the former types provision is made to enforce a rapid circulation of the liquid. In the latter designs the liquid is to remain in each as long as possible and flow slowly—in proportion to its feed—in an ordinary zigzag way down the still sections. These latter stills, extensively used in England and less in number on the European Continent, form the minority in use. Thus far the action of a fractionating still is the same, whether used for the distillation of ammonia or benzene. It will now be necessary to treat both kinds separately.

AMMONIA STILL

The ammoniacal liquor as it comes from the coke-oven plants contains free and fixed ammonia, the latter as dissolved salts. The stills consist, according to the work they have to perform, of three parts—viz., one to drive the free ammonia, one to liberate the ammonia by substitution of a stronger base in the salts and one to treat the liquor holding the liberated ammonia in solution. These three parts are usually united in two columns and at times in one. The fixed ammonia amounts to about one-third, but the part of the equipment in which it is distilled is generally of the same size owing to the bulk of water handled.

The upper part of the column into which the ammonia liquor is fed must be large enough to give the capacity needed to drive off all those compounds which are liberated by the application of heat, mainly ammonia, carbon dioxide and hydrogen sulphide. The liquid leaving this part of the still should contain only traces of free ammonia and no carbon dioxide. The sulphur compounds can be disregarded. Carbon dioxide, which is always present in crude ammonia liquor, is too often neglected and the detrimental part it plays in the operation has escaped proper attention. Though easily volatilized between 90 and 100 deg. C., it condenses, thus going into solution again with the ammonia liquor in the still. Pressure in the still has an impeding influence upon the liberation of CO_2 by heat. The presence of carbon dioxide in the liquor can be ascertained by adding a solution of calcium chloride to a sample which in the presence of CO_2 gives a calcium carbonate precipitate.

While the principles of a column still have been sufficiently described in general, there remains to be mentioned the so-called dephlegmating, a cooling action, which continually takes place on the inner walls of the sections above the liquid levels. As the steam introduced at the bottom is the only source of heat, it

follows that the bottom is the hottest part of the still and by the loss of heat through radiation as well as by the introduction of the liquor at the top, the temperature gradually decreases. This dephlegmating action is important in stills built for direct action, inasmuch as a large portion of the steam is condensed. The vapors are more saturated with ammonia the higher the column is relative to the heat added by the steam. In those stills in which the indirect distilling actions are more pronounced than the direct ones, the vapors are altogether richer in ammonia. In order to retain the indirect heat as much as possible, it is often desirable to counteract dephlegmation, by which the efficiency in this case is impaired. Such stills are covered with a magnesia-asbestos cover.

USE OF MILK OF LIME

To liberate the fixed ammonia, the liquor leaving the top portion of the still enters a mixing chamber in which a strong base alkali, usually milk of lime, is introduced. The lime does not react with the free ammonia, but it replaces the ammonia in its salts and liberates it. If the liquor contains carbon dioxide, it enters into combination with the lime, forming carbonate of lime, which sets stone hard in the still and makes frequent cleaning of the still necessary. For this reason it is advisable to have the liquor free of CO_2 . The most certain way to avoid the formation of a stone precipitate is to decarbonate the liquor before it enters the still. One way is to provide a preheater of any effective type, as a heat exchanger warms the incoming liquor by the outflowing waste liquor to a temperature over 90 deg. C. If from lack of efficiency this is not attained, a steam coil must be added. A pipe from the top of the heater is connected direct to the ammonia gas main of the still through which the liberated CO_2 is permitted to escape without entering the still. This pipe must be erected higher than the liquor feed pipe of the still and a feed valve for the liquor arranged on the heater inlet, otherwise ammonia liquor from the heater would be introduced into the ammonia steam pipe.

The milk of lime fed into the still should be kept at a constant strength, generally 10 to 15 deg. Bé. (15 to 23 deg. Twaddell, 1.07 to 1.1 specific gravity). It must be free from large pieces which are not easily suspended in water. It always pays to take care in the preparation of the milk of lime. The lime should be slaked and the solid parts which do not pass a fine grid removed. It is then stored in a receptacle where the water can drain off gradually to thicken. After that it is washed through a very fine sieve into the stirring tank, from which it is pumped to the still. An ammonia distilling column can with the above precautions be kept going for years without being dismantled. If the efficiency decreases, the hand hole lids of those portions of the still in which limed ammonia liquor is treated are removed and the internal parts cleaned by flushing with water at fairly high pressure by means of a hose and nozzle. A well-designed ammonia still, baffle hoods, overflow passages must be proportioned in size so that these removable parts can be taken out through the hand holes for cleaning, inspecting or replacing.

The lime-mixing chamber of the still must be provided with a drain cock of sufficient diameter to drain any lime sediments formed between shifts. A funnel-

shaped mixing chamber bottom with drain cock in the middle has been found most suitable for keeping the lime chamber permanently clean. To compensate for the lowering in temperature by the introduction of the milk of lime, a small steam pipe is brought into the lime-mixing chamber immediately above the bottom and the required amount of steam to supply the heat needed is allowed to enter. The steam pipe is arranged inside the lime chamber as a perforated coil to obtain sufficient agitation to prevent the lime from settling out. The end of the lime feed pipe is advantageously connected to the pipe through which the ammonia liquor enters the mixing chamber from the section above it, preventing the dip pipe from getting obstructed and at the same time insuring thorough mixing of liquor and lime.

The part of the still for treating the limed liquor overflowing from the lime chamber does not call for special remarks. It is advantageous to have this column standing alone at the side of the other, although more floor space is taken up. If it becomes necessary to dismantle a still, the lime still usually needs the cleaning and repairs and for this reason it is better to have it as a separate column.

The waste liquor outlet should be provided with a float valve so that the steam is automatically prevented from escaping through the waste-liquor pipe. The same result can be attained if the waste liquor is passed through a heat exchanger countercurrent to the incoming ammonia liquor. The waste liquor outlet of this apparatus must then be arranged at a height to keep the bottom section of the still sealed.

OPERATING PRECAUTIONS

As the pressure inside a still is very low, only very delicate gages can be used. If the still is shut down without closing the cock of the gage, it will be ruined by the vacuum created in the still after the condensing of the steam. It is much better to provide the steam-inlet pipe of the still with two valves a short distance apart. A high-pressure steam gage is connected between the valves. The lower valve is set according to the steam requirements of the still and the upper one is opened to show a certain pressure on the gage which, of course, is much higher than the actual pressure inside the still. With the upper valve the man in charge has to compensate for variations in the steam pressure by keeping the pointer of the gage constantly at the mark. The bottom section of the column and the lime-mixing chambers are provided with water gages, and from their readings the operation of the still can be judged to a certain extent.

If a new or empty column still is started up, the steam must be applied slowly to warm up all parts gradually to prevent an uneven expansion of trays, mantle and flanges, which are apt to crack easily if suddenly affected by great changes of temperature. The steam condenses and the water fills the trays and seals the overflows. It should take at least four hours to warm up a cold still of average size. As soon as a thermometer immersed in the ammonia steam main shows about 100 deg. C., the liquor-feed cock is opened and the lime pump started. Liquor feed and steam supply are gradually increased as long as the waste liquor does carry recoverable ammonia. The ultimate analysis should not show above 0.005 per cent NH_3 . The liquor in the water gage of the lime chamber should

remain steady and at its proper level. The quantity of steam admitted to the lime chamber must be just enough to compensate for the cooling by the introduction of the milk of lime to keep the liquor boiling gently. Too little steam in the lime chamber makes itself conspicuous by a rattling noise with which the steam enters the liquid. A surplus of steam causes the contents to boil over. It is indicated on the water gage of the lime chamber and may cause the whole still to boil over all of a sudden.

CAUSES OF TROUBLE

Bad operation of a still makes itself felt in three ways: 1. The ammonia vapor is too weak, containing too much water. 2. The still boils over. 3. The waste liquor is too rich in ammonia with normal liquor feed.

An excess of steam compared with the liquor feed must first of all be looked for, especially when the ammonia liquor is as weak as 0.6 per cent NH_3 . If steam supply and feed are adjusted in proper proportion, there is a possibility of a tray having become leaky so that baffles and overflows of one section have become unsealed. No water is obtained from such a tray when opening the hand holes. It also happens that with a faulty still the baffle edges do not reach far enough down. In such a case the still should be increased in height by adding sections. An improvement can be made by placing a dephlegmator over the top section and pass the ammonia through the dephlegmator pipes round which cooling water circulates. The writer had a singular experience in this connection when called to a plant to restart an ammonia still which would not operate properly, although it had been cleaned thoroughly and had even been dismantled completely for thorough inspection. After the first failure the still was opened and it was found upon removing the hand hole lids from the top section that the condensed water vapors did not run straight down outside the column, but congregated along the edges of the flanges before they fell down. This indicated that the foundation of the column had given way on one side. Although the malalignment was so slight that it could not be noticed with the eye, it had caused the overflows on one side of the sections to become unsealed and the steam traveled upward without passing through the liquor.

If the ammonia vapor is too weak, the still is either overfed and must be restarted with less pressure (otherwise an overflow results) or else the waste liquor outlet is sure to be obstructed. The latter obstruction can be detected by the water gage of the bottom section being filled completely. If the water gage on the lime chamber shows an abnormally high level, it indicates that the overflow pipe from the lime chamber to the lime still is obstructed. If both water gages should remain normal, the dip pipe by which the liquor enters the lime chamber from the section above is obstructed. This can quickly be ascertained by draining the lime chamber a little, reducing the level in the gage. If, on opening the liquor-feed pipe to the still, the liquor stands at its old level, the dip pipe is open and the obstruction must be found higher up.

An obstruction in the upper sections of the column can almost always be traced to the first overflow of the top section and is due to tar having been mixed with the liquor. The light oils of the tar distill over with the ammonia and their residue collects as a

soft pitch under the overflow, gradually obstructing it. This can also be avoided by preheating the liquor to its boiling point. If the tar comes in great quantities, it will be carried further down and meet so high a temperature in the lower sections that it will flow right through the still, if it is not carried away in lime deposits.

If, in a properly adjusted still, the waste liquor contains too high a percentage of ammonia, this is due to the still becoming dirty. Lime sediment deposits around the baffles so that the steam is not divided into fine streams when passing through the liquor, but finds its way through large openings. The remedy is obvious.

When liquor heat exchangers are employed, a leak in the ammonia lime, which is under greater pressure than the waste liquor, allows ammonia to pass into the waste liquor. An easy way to discover this is to throw a small quantity of fluoresceine, about 10 g. per ton of liquor, into the high level ammonia liquor tank and stir it up so that the liquor gets an even fluorescent green color. If the preheater leaks, the color will be found very quickly in the effluent waste liquor, as the coloring power of this aniline dye is so intense that it can be traced with the eye in minute quantities.

BENZENE STILLS

What has been said about the ammonia stills also applies to a certain extent to benzene stills, which in principle and in design of the single sections correspond exactly with the ammonia stills.

Benzene stills are built in single columns and consist of sections of equal design right through. Dephlegmating action in the still itself is not desired. As the oil enters the top of the still at a temperature at which the vapor pressure of the benzene is high, such columns must be well covered to reduce radiation as much as possible. There must be as many steam passages and baffles on each tray as can be arranged and dead spaces must be avoided.

To obtain the best heat economy, the incoming rich oil first passes through a tubular heat exchanger in which it absorbs the heat of the benzene vapors leaving the still. It then circulates through a second heat exchanger, absorbing the heat of the effluent oil. Then it passes through a preheater with steam coils or specially shaped heating elements offering large heating surfaces, from which it is charged into the still. By these means a low steam consumption in the still is obtained.

A benzene still rarely gets out of order or obstructed. The oil does not deposit solids while in the still. If the liquid boils over, it is due to overloading, a sudden increase of steam pressure or water in the oil. For proper operation of a benzene still, it is important that the effluent oil leaving the still should contain only traces of benzene. It should leave the still at a temperature not below 150 deg. C. to be sure that it is not contaminated with water, which decreases its absorbing properties and increases the steam consumption in the still.

Most of the benzene column stills work only with direct steam, which should be superheated to prevent too rapid condensation, allowing the condensed water to mix with the oil. Some builders provide a few of the sections with steam coils, thus reducing the amount of direct steam and decreasing the chances of getting watered spent oil.

The benzene still designed by Dr. Gasser has tubular sections which are horizontally placed one above the other in a scaffold of joists and are connected by pipes. The oil has to make a round trip horizontally through each section, and flows over a steam coil all the way downward through all the sections. Just enough direct steam is let into the bottom section to accelerate the distilling action. With such a still it is very easy to keep the oil free from condensed water. The steam consumption is considerably lower than with the ordinary column still. The sections, being arranged in single units above one another, are easily accessible. Also it is possible without difficulty to redistill the crude benzene continuously and recover the heavier products, toluene, xylene, solvent naphtha, etc., as separate fractions at the same time.

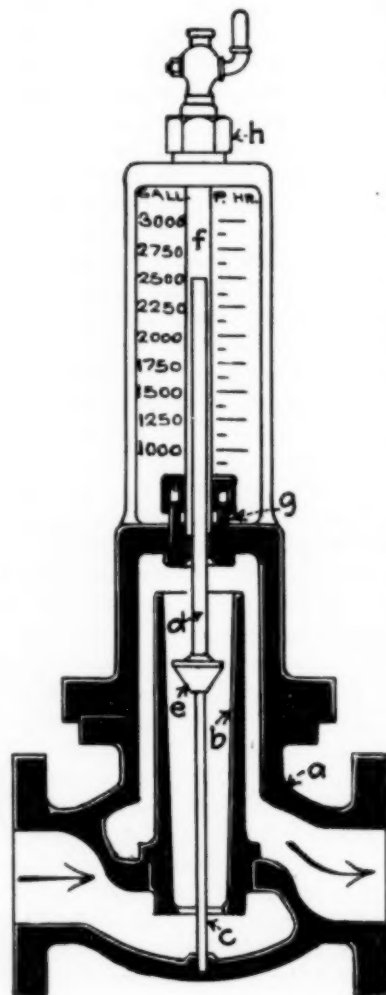
CONTROL OF COLUMN STILLS

Control of the column stills is had by adjusting the steam consumption, the amount of liquor or oil passing through, the steam pressure, temperature and composition of the effluents.

The waste of steam with continuous ammonia stills can be considerable before being observed. In large plants or where steam is generated directly by fuel, a steam meter should be connected into the steam lines leading to the stills. There are a number of reliable steam meters on the market which are too well known to call for a description in this connection.

Ammonia liquors should be passed through a meter of the piston type, as wheel and propeller meters are not as reliable, are too sensitive to changes of temperature

and too easily get out of order or become obstructed by tar and naphthalene deposits. The flow meter shown in section in the figure is a simple, cheap and reliable device which is not generally known and is equally adaptable to ammonia liquor, oil or benzene. It consists of a valve-shaped body *a* with a tubular seat *b* which is slightly tapered inside. In the center of the tube *b* a spindle *c* is rigidly fastened and screwed into the bottom of the valve body. Over it a tube *d* slides vertically, to which is fastened on its lower end a valve cone *e*. The tube *d* projects on top into a gage glass *f* fastened by a lower gland *g* and an upper one *h*, the latter being provided with a vent cock on top. Behind the gage glass an enameled scale is arranged, graduated in liters or



gallons per hour. The feed cock is arranged on the outlet end of the meter. The liquor, oil or benzene passing through the meter lifts the cone *e* in proportion to the amount of liquid passing through, and the top of the tube *d* indicates on the scale how much feed is applied.

The advantage of the instrument rests with the fact that the movement of the indicating tube *d* is not impaired by a gland or similar guide, but moves freely in the glass tube, which is under the same pressure as the inside of the meter. The instrument is also built in another type in which the scale is arranged underneath the valve body and the indicating spindle protrudes thereby through the bottom downward. The meter must be arranged with a bypass so that the still need not be stopped should the gage glass break. As brass is quickly destroyed by the corroding effects of ammonia upon copper, these meters are made entirely of iron for use on byproduct plants.

Steam pressures are read on ordinary steam gages with large dials; recording gages are rarely used on stills. Temperatures are of the greatest importance. To make sure that the temperatures are actually read and observed by the men in charge, the use of mercury steel tube thermometers which have dials exactly like steam gages are recommended. Excepting the rigid types, they offer the further advantage that they can also be supplied with flexible connection between indicator and mercury stem. The mercury stem is immersed in any remote corner or up on top of a still or main, while the indicator, which is connected to the stem by means of a flexible capillary wire, can be fixed in a convenient spot where it can be continually seen. This makes it possible to arrange all the thermometers belonging to a benzene or oil still in one row so that the operation of the still and the attached apparatus can be observed at a glance. Where it requires special attention to keep the spent oil at the required temperature the outlet thermometer of the still should be arranged for indicating and recording at the same time.

Production of Oil From English Shales

An interesting report upon the shale deposits underlying the county of Norfolk, England, has recently been issued, reports Consul General Skinner, of London. The shale is said to be found at shallow depths and can be delivered at the principal works at a cost of 5s. (\$1.21) per ton. The yield of a good quality of crude oil by means of treatment in specially designed retorts is reported to be satisfactory, and the nearness of the deposits to the surface makes possible the removal of the overlay and the excavation of the shale by means of mechanical diggers.

Two commercial seams of shale have already been opened up and are at the present time available for production, though a number of other shale seams have been disclosed beneath these in boring operations to test the full depths of the shale deposits.

The upper seam is a hard, well-laminated body of shale 8 ft. thick, having two small bands of "blaes," or less hard and laminated shale, intercalated with its other members, respectively, 6 in. and 5 in. thick. The whole seam, including these bands, can be classed as rich commercial oil shale. Variations in physical properties and chemical composition naturally occur in a seam of this thickness, and these differences have been carefully noted and analyzed.

The lower seam is 8 ft. thick. Its roof is 37 ft. from the surface and its base rests on a band of pyrites at 45 ft. which forms a good hard floor. This is a good mineable seam, being composed of a black shale 4 ft. thick, and a lower 4-ft. seam of hard, dark-green shale.

OIL CONTENT

The oil content is present in a dual form—namely, in a state of free oil absorbed from some source of liquid oil beneath or in juxtaposition to the beds affected, and, secondly, in the form of a heterogeneous material of unknown origin, indigenous to and probably deposited along with the other elements of the shale at the time of its inception.

The yield per dry ton of shale treated is stated to average 33 gal. of oil content, from which may be recovered 7 gal. of gasoline, 9½ gal. of kerosene, 9 gal. of lubricating oil, with a bituminous residue of 50 lb., equivalent to 5 gal.

METHOD OF TREATMENT

The report referred to also contains the following particulars in connection with the retorting methods employed for the extraction of the oil:

Shale must be distilled at a comparatively low temperature in order to obtain and preserve both the liquid oil and solid products, the resulting incondensable gases being used for heating the retort. In the case of a rich shale, the lower the working temperature the greater is the quantity of light spirit and the less gas.

In the early days of the Scottish shale-oil industry the original retorts were of the horizontal type, like those employed in gas making, but these were rapidly discarded and the vertical type universally adopted. In these vertical retorts the shale is fed into the retort from the top and exposed to a gradual increase of temperature, by which means the light, medium and heavy oils are released in rotation. Access of air must be avoided in order to prevent burning the oil, with consequent production of gases. In practice, it is found that steam protects and helps to carry away rapidly the oil as it is formed, and at the same time it increases the yields of all grades of oil as well as of ammonium salts. In the development of the Norfolk shales toward commercial production it has been essential to devise special methods of retorting. The suitability of these methods is dependent upon factors inherent in the shale itself, and, consequently, foreign to the specific needs common to the shales of other and older fields.

It was the appreciation of these necessary departures from ordinarily accepted retorting practices that ultimately led to the design, construction and operation of a special retort which not only gives a yield of oil above that obtained in the ordinary laboratory retorts, but, on fractionation, the crude oil from this retort separates into spirit, kerosene and lubricating oil equal in quality and percentage quantities to those obtained from the crude oil of the laboratory tests. Further, the scrubbing of the gas (which was not attempted with the laboratory retorts) has yielded a further substantial percentage of light spirit.

With regard to the question of the yield of ammonia from the shales, various tests have been made of core samples of the upper seam, and the average yield of sulphate of ammonia over the whole thickness of the seam was 22.6 lb. per dry ton of shale. The nitrogen content, running as high as 0.75 to 0.95 per cent, has formed other organic substances, such as pyridine.

The German Vegetable-Fiber Industry

THE attention of textile men in Europe and elsewhere is being attracted to the remarkable results being attained in Germany in the manufacture of yarn from grasses, plants, leaves, etc., reports H. W. Adams, representative of the Department of Commerce in Germany. This new German industry is centered in the plant of the Deutsche Faserstoff-Gesellschaft (German Fiber Material Co.) located in Fuerstenberg, in Mecklenburg, Germany.

This plant was established in 1912. During the first year in which it was in operation it confined its activities to the manufacture and sale of the fibers. In 1913 spinning machinery was set up, and since then the spinning of yarn from these fibers has been carried on on an ever-increasing scale. During the eight years of its existence the products of this concern have covered a wide range of vegetable fibers, including China grass, Australian seaweed, jute, old jute rags and shoddy worsted yarn. Besides the above-mentioned fibers a number of others were worked up during the war by the same firm and extensively used in the various lines of the German textile industry. Some of these fibers were abandoned after the war, owing to the fact that the supply thereof to be found in Germany was not sufficient to warrant their permanent use. Among these fibers are to be mentioned nettle, hops, willow bark, pine needles, cornstalks, ginster and asparagus. It has been found that the fiber taken out of pine needles and cornstalks can be readily used in the paper mills, it being possible to produce a very strong and tough paper therefrom.

Prior to the outbreak of the war the Deutsche Faserstoff-Gesellschaft was able to secure sufficient supplies of China grass, Australian seaweed and jute, and it focused its efforts on these fibers. During the war the importations of this raw material were cut off and have not as yet been resumed. Since the close of the war this concern has confined itself mainly to the manufacture of yarn from old jute rags.

WIDE FIELD IN USE OF SOLIDONIA IN WOOLEN INDUSTRY

The vegetable fiber derived from China grass is known as solidonia. It is similar to ramie, which is known and used in the United States. The Deutsche Faserstoff-Gesellschaft by means of a special process produces a long, fine, soft and curly fiber. The curliness of the solidonia fiber presents a special feature. This fiber looks very much like wool and mixes readily with that product, thus opening a wide field for its use in the woolen industry.

This solidonia fiber was introduced into the United States shortly before the outbreak of the war and was taken up by various textile industries, especially by concerns manufacturing woolen goods and underwear. German textile experts assert that solidonia is of special importance for use in the manufacture of underwear, as it serves to prevent the garments from shrinking.

In Germany solidonia gained a wide field of use on account of the shortage of wool during the war. As a substitute for linen, solidonia has been used in Germany for the manufacture of table linen of beauty and strength. It has also been used for machine belting. German hosiery and underwear mills have produced from it socks and stockings which are difficult to tear,

unshrinkable underwear and sporting jackets of fine quality and strength.

The German woolen mills have manufactured an army cloth which, composed of 75 per cent wool and 25 per cent solidonia, it is asserted, surpasses in tensile strength any pure-wool cloth. Similar results are claimed with respect to paper-makers' felts, which, with a percentage of solidonia mixture, show a considerable increase in strength. Furthermore, women's and men's clothing composed of half solidonia and half wool or shoddy, especially in piece-dyed goods, have found a welcome on the market. In textile circles in Germany it is declared that there is an unlimited field for the use of this fiber. Prior to the war the price of solidonia in Germany was two-thirds the cost of good staple wool. No actual comparison can be given at the present time, as none of this raw material is coming into Germany. In 1914 solidonia in the carded stage found a ready market at 30c. a lb., delivered in New York or Boston.

SPLENDID RESULTS OBTAINED IN USE OF POSIDONIA FIBER

Another fiber from which the Deutsche Faserstoff-Gesellschaft has obtained splendid results is the fiber known as posidonia. This is also a vegetable fiber. It is derived from seaweed which is dredged in Australia and cleansed and washed in sweet water. Brought to Germany, the fiber is subjected by this concern to a chemical treatment for the purpose of softening it and making it resilient, the original fiber being stiff, harsh and brittle. The staple of this fiber is declared to be equal to a medium staple wool, and it is spun on the worsted and woolen system. This fiber is characterized by an elasticity and springiness, and the cloth which is made out of pure posidonia appears to show scarcely any creases. German cloth mills have mixed posidonia with wool or shoddy, and cloth of good strength and appearance has been obtained. German textile men believe that this fiber, by reason of its springiness, will have a wide field of use in the carpet industry. This fiber sold at half the price of shoddy before the war. Since the war none of this raw material has been imported into Germany.

UNUSUAL RESULTS OBTAINED WITH JUTE

The principal way in which jute has been employed in the United States is in the form of cheap lining and burlap. The Deutsche Faserstoff-Gesellschaft has accomplished some unusual results with jute. By a special process of chemical treatment a long, fine and beautiful fiber is being produced therefrom, a fiber which can readily be spun on the worsted system, pure or mixed with wool.

This same concern has secured fine results from old jute rags, which are being cleansed and made into shoddy, which also can be spun on the worsted or woolen system.

The inventor of all the processes has been the managing director of this company's plant since its establishment in 1912.

This plant began work with a total of fifteen employees. Its personnel now numbers over 250. The buildings have been enlarged and new ones erected, and plans are on foot to make still greater additions. The output of this plant is 10,000 lb. of treated fiber per day of eight hours. The worsted mill is now continually working, being operated in three eight-hour shifts.

Defects Arising in Steel During Fabrication

Microscopic Appearances Caused by Surface Defects, Cold Working, Overheating, and Burning—Nuclei of Fatigue Fractures Are Associated With Phosphorus Bands—Photographs of Changes in Structure During Annealing of Steel Castings Are Also Given

By AUSTIN B. WILSON

GENERALLY speaking, by "defects in steel" it is understood that those defects which can be avoided by the employment of the proper practice are meant. The effects of almost all defects can be more or less mitigated in some way and in many cases entirely eliminated. There are, however, some defects which cannot truly be regarded as such, since, although their presence is not desirable, they do not under favorable conditions exert a marked influence upon the behavior of the metal. "Defect" in reality should be used to designate only those substances or conditions in the metal which make for failure in service.

It is possible to divide the defects which cause early failure into two great classes—defects due to errors in chemical composition and defects due to the treatment of the steel during the process of manufacture. Of these two great classes the latter is undoubtedly the one of greater importance inasmuch as it is the one more frequently met with.

The errors of the first class are due as a rule either to errors in the original charge or from reactions which occur during melting and refining.

Unsuitable mechanical properties are the direct result of larger errors in chemical composition, but this phase may here be entirely disregarded, as this is not in reality a defect in the material, but rather an error in the choice of metal to be used for the particular purpose. Such a case would be the selection of medium carbon forging steel for use as a watch spring.

LOCALIZED CORROSION

Larger chemical errors may also produce an undesirable tendency toward corrosion. As it is highly

improbable that a cheap and practical method of producing an incorrodible iron or steel will ever be found this phase may also be quickly passed over. On the question of corrosion there are two schools about equally divided. One claims that corrosion is purely electrolytic and takes place only by means of small galvanic cells formed by impurities. The other asserts corrosion is due to direct oxidation of the iron by the oxygen of the water. The former attempts to prevent corrosion by use of very pure iron. The latter, while admitting that pure iron commences to rust less quickly than does steel, claims that once the corrosion has started it takes place with equal rapidity.

Whatever the mechanism and theory of the process of corrosion may be, it is certain that some impurities heighten the tendency in this direction. Figs. 1 to 4 illustrate this very well in the case of tinplate which contained pinholes in the tin coating. Fig. 1 is the top of a can upon which a number of pinholes can plainly be seen. After photographing, this can-top was cut up and microsections were taken through and near to some of the pinholes shown. Fig. 2 shows a particle of silicate slag near the surface of the steel base which has not started to corrode, although it can readily be seen that the tin coating is perforated. Fig. 3 is another spot very close to the former where corrosion of the steel has just set in. Fig. 4 is from another specimen showing corrosion in the last stages.

The reader may well ask for further explanation of the above phenomena before proceeding. To begin with, the pinholes in the tin coating are due to the evolution of gas caused by raising the temperature of the steel in the tinning process. This gas, it has been con-

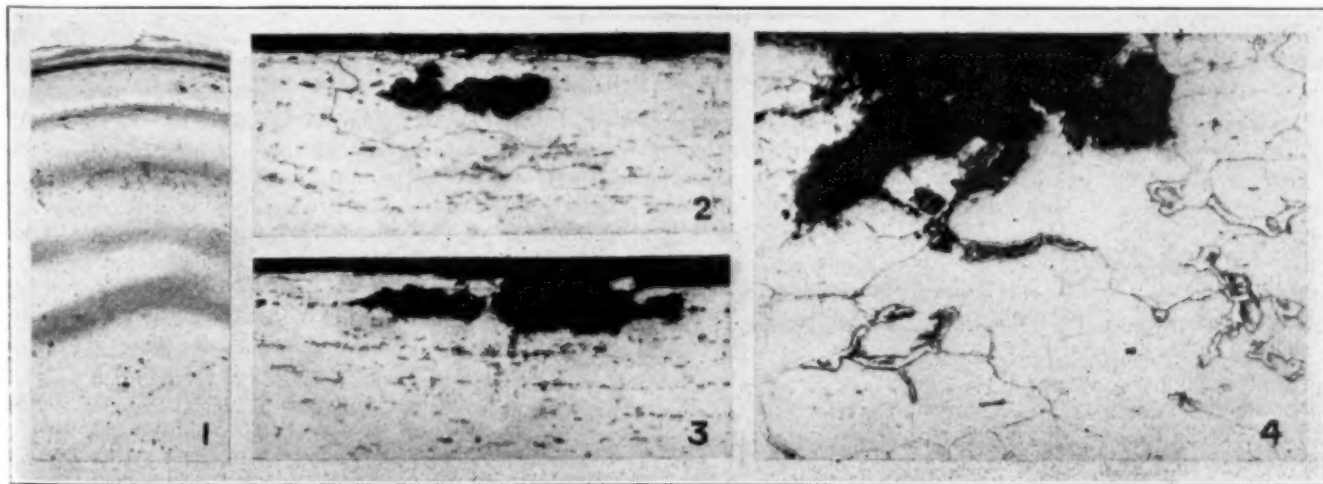


Fig. 1. Top of can, showing pinholes.

FIGS. 1 TO 4. PINHOLES IN TINNED PLATE DUE TO SLAG INCLUSIONS

Fig. 2. Slag near surface, no corrosion. $\times 325$.
Fig. 3. Slag near surface, corrosion starting. $\times 325$.

Fig. 4. Corrosion in last stages. $\times 325$. Figs. 2, 3 and 4 are etched with HNO_3 .

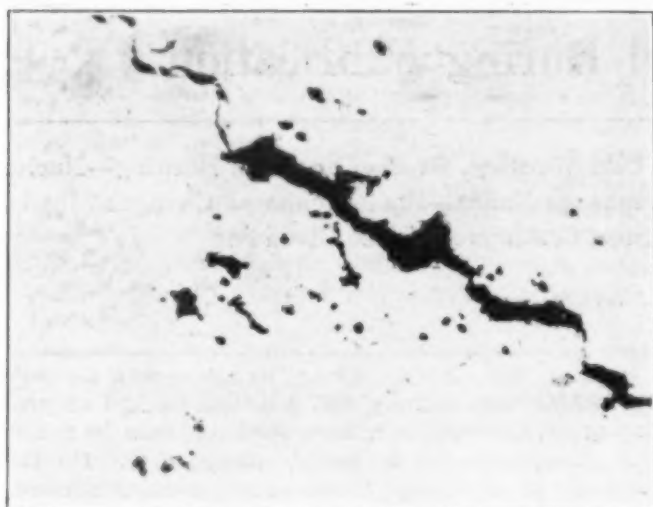


FIG. 5. UNOXIDIZED CRACK IN HEAD OF RAIL.
UNETCHED. $\times 200$.

clusively proved, was absorbed during the pickling just prior to the tinning, and the presence of slag is known to favor this absorption. The iron of the base being electro-positive to the tin, as soon as opportunity offers a galvanic action is set up at and through the perforations in the tinplate, the iron going into solution in preference to the tin and the steel rapidly corroding away. This corrosion can be diminished by the making of cleaner steel—i.e., steel freer from slag and oxide inclusions.

Errors in composition of less magnitude are a greater menace in steel than those just described. In case there results metal of unsuitable mechanical properties the error is soon discovered, but in cases of smaller chemical errors it frequently occurs that the defect is not found until it has caused irreparable damage. These smaller errors may lead to the formation of brittle impurities which are suspended or mechanically entrapped in the steel or to the formation of brittle intercrystalline envelopes which destroy the cohesion of the metal. Not all impurities, however, are mechanically held. Some, such as phosphorus, enter into solid solution with the free ferrite which is present and thus affect its ductility to a great extent.

In connection with the smaller errors mentioned above it might be well to refer in particular to the alloy or "special" steels. In heat treating this class of steel a slight error in composition may give rise to vastly different mechanical properties than was expected from the particular thermal treatment employed.

Practically the only possibilities of defects in chemical composition which are of sufficient importance to be given consideration are those which arise from the incomplete removal of phosphorus, sulphur and other undesirable elements. It is too well known to require more than a passing reference here that abnormal amounts of phosphorus and sulphur are the cause of "cold-shortness" and "red-shortness" respectively.

DEFECTS DUE TO IMPROPER HEATING

In considering the defects which are caused during fabrication it is well to begin with those which may originate during the casting of the metal or even prior thereto. Cracks, segregation and non-metallic inclusions originating in poor practice in teeming, or to events happening during solidification of the metal, have already been briefly noted by the author in an

article appearing in *CHEMICAL & METALLURGICAL ENGINEERING*, vol. 23, page 1,161, Dec. 15, 1920.

Defects originating in the hot-working will now be considered. Under this heading fall all operations such as forging, rolling, pressing, hot stamping, etc.—in fact, all operations in which the steel is worked at temperatures exceeding or very close to its critical point. These defects are entirely under the control of the steel-maker and can usually be traced to either carelessness or ignorance.

It sometimes occurs that through some inadvertence, possibly the breaking of a pyrometer thermocouple, possibly non-uniformity in the heating of the furnace, one piece or perhaps a certain portion of a piece is heated to a temperature much higher than the rest. This causes the metal at that spot to become weak and brittle and, should the piece be subjected to mechanical working, might cause the formation of internal cracks or fissures which would be revealed only upon failure. In Fig. 5 is shown an internal crack found in the head of a rail. This crack, unlike a crack exposed to the oxidizing influence of the air, was found to be free from oxide and probably originated as just explained.

COLD-WORKING

Finishing at too low a temperature or "cold-working" induces "strain-hardening," which, although sometimes permissible, often leads to very serious results. Where this strain-hardening is used merely to stiffen small articles not to endure any great stress it serves its purpose well. It frequently happens, however, that cold-worked materials, for instance bolts or rivets strain-hardened in forcing into place, are called upon to sustain important loads and at the same time are subjected to alternating stresses. Experience has proved that strain-hardened metal is particularly unreliable in such cases. It is wise to avoid the use of cold-worked metal where important loads must be borne.

Frequently cold-working occurs through ignorance or carelessness in engineering construction, for instance cases such as forcibly "setting" pieces which do not fit properly or correcting small irregularities in shape by hammering. In tank building bolts and rivets are often hammered until quite cold, although it is an established fact that a rivet with a distorted structure corrodes much more rapidly under certain conditions than does a well-annealed rivet.

In a few cases, notably that of cold-drawn wire, strain-hardened metal is quite reliable as far as strength is concerned, but even the increase of elastic limit so caused does not accomplish much in preventing failure from fatigue. Fig. 6 shows the badly distorted microstructure of a severely cold-drawn wire which gave poor service as an automobile wheel spoke. Fig. 7 shows a finer, more uniform and much less distorted structure in a wire of exactly the same composition. This structure was obtained by "patenting," a form of heat treatment which gives to wires a fine, sorbitic structure. This wire gave good service, and although of slightly lower elastic limit far surpasses the former in resistance to fatigue.

Too severe cold-working also causes defects other than those mentioned above. These are defects which are discovered during fabrication and which merely result in scrapping. The author has in his possession a wire which has been overdrawn so severely that numerous checks have occurred throughout its length.

Cold-working of steel results in leaving the struc-

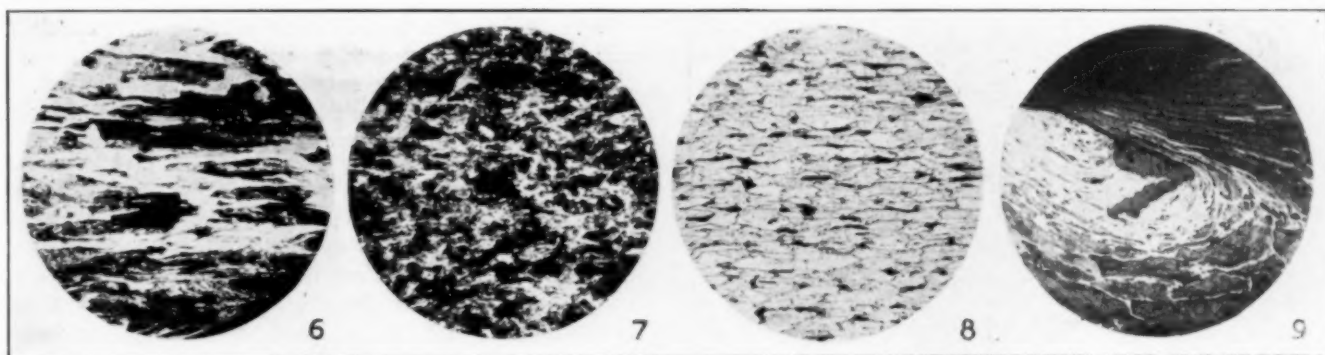


Fig. 6. Badly distorted structure of cold-drawn wire spoke. Etched with picric acid. $\times 100$.

Fig. 7. Sorbitic structure of "patented" wire spoke. Etched with picric acid. $\times 100$.

Fig. 8. Distorted structure of low-carbon cold-drawn wire. Etched with nitric acid. $\times 50$.

Fig. 9. Distorted structure at bearing surface of rail, also oxide streak (gray) in seam. Etched with picric acid. $\times 50$.

ture of the metal in a distorted and strained condition. It is generally accepted, however, that cold-working does not permanently damage the metal as long as the tensile strength continues to increase. Fig. 6 as well as Fig. 8, a low-carbon wire, illustrates typical cold-drawn and therefore severely distorted wire. Although it is less frequently a cause of defects than its opposite,

trains at a high speed. If worked unequally different portions may recrystallize at different rates on annealing, thus causing cracks. This, however, is not so likely to occur in steel as in certain non-ferrous alloys.

An excessively rapid deformation of the metal even when at a sufficiently high temperature may likewise result in cracks or checks. No examples of these are necessary, as they are illustrated by photomicrographs illustrating other defects, their appearance depending upon their exposure or non-exposure to oxidizing influences.

DEFECTS DURING HOT-WORKING

For forging an ingot should be at least twice as great in cross-section as the finished shape. It sometimes happens, however, that through a desire to effect economy in the forging operation a smaller ingot is used. This results in a very superficial working of the metal. After forging the structure will be very non-uniform, the metal near the surface being fine grained, that near the center being coarse and brittle.

In addition to the foregoing there are several more or less minor defects which are formed during hot-working. Among these are the laps, seams, etc., due to the partial welding of portions of the metal which have become overlapped during the rolling or forging. Fig. 10 is an instance of this. Another defect in this class is the rough, uneven finish caused by scale, etc., on the surface being rolled into the metal (Fig. 11). The former defect should be weeded out by careful inspection.

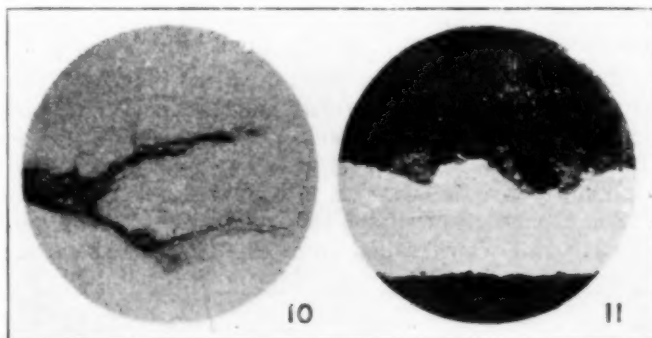


Fig. 10. Lap in nickel steel forging. Etched with picric acid. $\times 50$.

Fig. 11. Scale rolled into surface of sheet. Unetched. $\times 100$.

too drastic working is likewise dangerous in cases where the additional hardness and strength imparted by the cold-working is relied upon.

An example of a very superficial cold-working is shown in Fig. 9, a photomicrograph taken just under the bearing surface of a rail—i.e., at a point which has been subjected to the severe cold-working of heavy

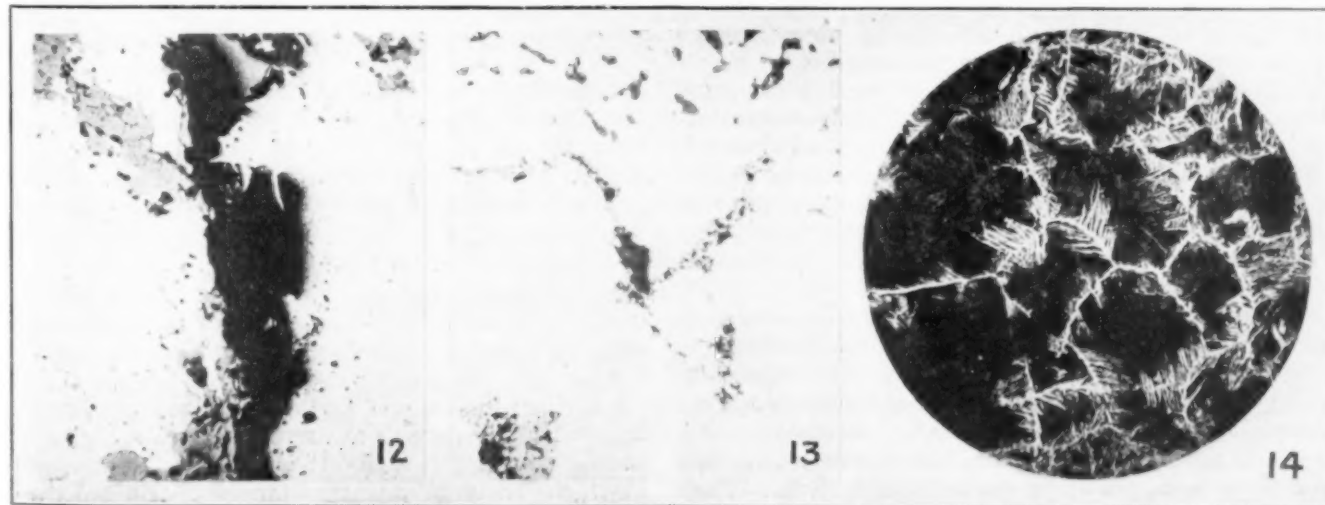


Fig. 12. Oxide around grains in burned steel. Unetched. $\times 100$.

Fig. 13. Oxide around grains in burned steel, also dark pearlite grains. Etched with picric acid. $\times 100$.

Fig. 14. Overheated steel. Etched with picric acid. $\times 50$.

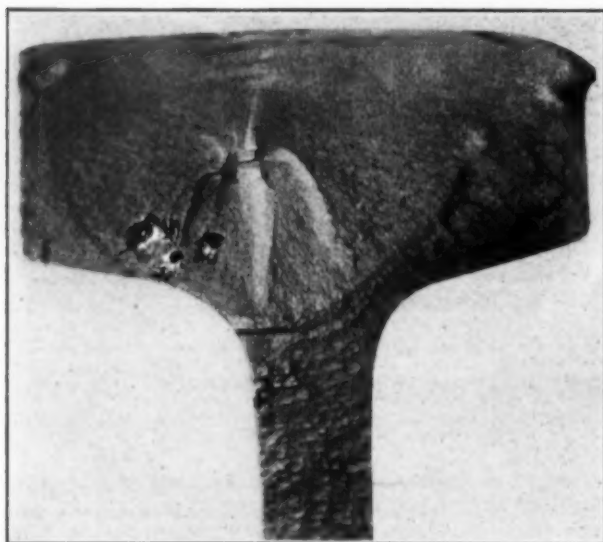


FIG. 15. CROSS-SECTION OF RAIL SHOWING TRANSVERSE FISSURE IN HEAD WHICH CAUSED FAILURE

tion before the material is allowed to leave the plant. The latter may be prevented only by carefully blowing the scale from the surface of the metal before it enters the rolls.

Although often confounded and spoken of as one and the same, there is a great difference not only in the structure but also in the properties of "burnt" and "overheated" steel. Steel that has been "burnt" has been heated above the point of incipient fusion and cannot be restored short of remelting. It is both "cold-short" and "red-short." Its cohesion has been destroyed,

and is well known as granular pearlite or spheroidized cementite. The tendency toward this structure is heightened by the presence of any free cementite.

The results of heating in an injurious atmosphere are too well known to need more than passing mention.

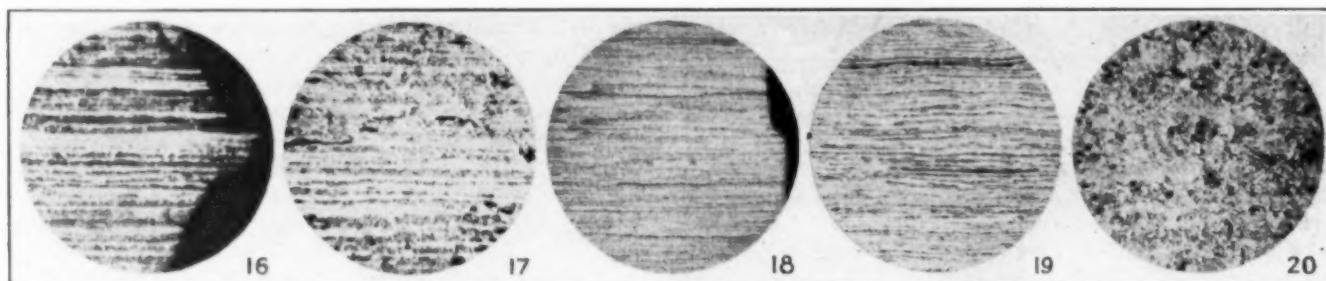
HARDENING TROUBLES

In quenching defects may be caused by any of several conditions. If carried out from too high a temperature a coarse martensitic structure is formed which is exceedingly brittle. If from too low a temperature nothing is accomplished. The quenching effect must be nearly equal throughout the entire piece or severe internal stresses may be set up, often sufficiently great to cause immediate cracking. The quenching medium plays an important part, some quenching mediums giving much more drastic effects than others.

Defects arising from improper tempering may likewise be summed up in a few words. Tempering at too high a temperature undoes all the work of the quenching. Tempering at too low a temperature leaves the steel more brittle than is desired and does not remove enough of the effects of quenching. Tempering unevenly throughout results in severe internal strains, as in quenching non-uniformly.

FATIGUE FAILURES

Before closing, the author would like to call attention to a class of failure which is due usually to some inherent defect in the steel. These are the "fatigue" failures. This class of failure is met with in rails and is known as a failure from a "transverse fissure." Fig. 15 is a photograph of the top portion of a 100-lb. open-hearth rail which failed from this cause. The fissure



FIGS. 16 TO 20.

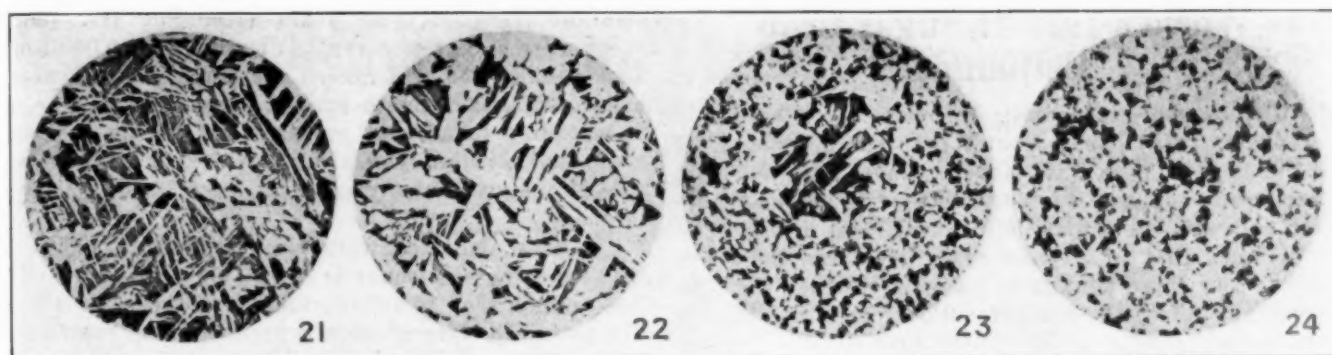
- Fig. 16. Streaked structure at nucleus of transverse fissure. Etched with Stead's cupric chloride reagent. $\times 10$.
 Fig. 17. Crack in rail head following high-phosphorus (light) streaks. Etched with cupric chloride. $\times 10$.
 Fig. 18. Streaked structure in nickel steel wrist-pin shown in Fig. 14 (page 1,211). Etched with cupric chloride. $\times 10$.
 Fig. 19. Streaked structure in cross-section of tin-plate. Etched with cupric chloride. $\times 200$.
 Fig. 20. Uniform, unstreaked structure in rail rolled from a reheated bloom. Etched with cupric chloride. $\times 10$.

the grains being surrounded by oxidized films, as in Figs. 12 and 13, which effectually prevent welding. "Overheated" steel has a coarse fracture and structure (Fig. 14) and, like "burnt" steel, is extremely brittle. Unlike "burnt" steel it can, however, easily be restored by suitable heat treatment. "Overheated" steel results from long annealing at a temperature below that of incipient fusion.

Reheating for a prolonged time even at a moderate temperature has a detrimental effect upon steel to be used for certain purposes. Treatment of this kind, say a long tempering just below the critical point of a steel containing pearlite, causes the pearlite to break up and the Fe_3C to form small globules in a ferrite matrix and eventually to coalesce into much larger particles. Thus we have large cementite islands surrounded by ferrite. This structure is the softest, weakest and most ductile which can be assumed by any steel containing pearlite,

can plainly be seen in the head of the rail. It shows the detailed fracture typical of "fatigue" fractures. Near the center of the smooth area can be seen the nucleus at which the fracture started. Once started it gradually progressed under the alternating stresses produced by passing trains until the surface was reached and the head completely broken.

It is, however, not with the progression of the fracture, but rather with its origin, that the writer would deal. A recent paper before the American Institute of Mining and Metallurgical Engineers presented convincing data that the origin of the transverse fissure—the nucleus—invariably occurred in brittle high-phosphorus areas in the rail. It also showed that rails in which the phosphorus was uniformly distributed rarely failed in this manner. A few photomicrographs illustrating the above are included herewith. They are all etched with Stead's cupric chloride reagent, which



FIGS. 21 TO 24. STRUCTURES REPRESENTING STAGES IN THE ANNEALING OF CAST STEEL.

Fig. 21. Typical Widmanstätten or cast structure showing bad annealing. Etched with picric acid. $\times 75$.

Fig. 22. Poor annealing. Etched with picric acid. $\times 75$.

Fig. 23. Fair annealing, only trace of cast structure remaining. Etched with picric acid. $\times 75$.

Fig. 24. Good annealing. Etched with picric acid. $\times 75$.

darkens the purer metal and leaves white the portions higher in dissolved impurities such as phosphorus.

Fig. 16 is a longitudinal section through the nucleus of a transverse fissure. The pointed projection is formed by a portion of the nucleus. This specimen has a distinct banded structure, showing a poor distribution of phosphorus, and it will be noted that the broadest white band—i.e., the most pronounced phosphorus segregation—occurs exactly at the nucleus. Fig. 17 was taken near the nucleus of another fissure. It shows the same banded structure and a longitudinal crack following closely the white high-phosphorus bands. Fig. 18 typifies the same structure found at the nucleus of a fatigue fracture which occurred in an airplane wrist-pin. Fig. 19 shows this same type of structure as found in poor tinplate.

As stated above, proper heat treatment will remove almost all danger from this source. The steel should be heated to a temperature well above A_c and held there for a long time to allow the proper diffusion of phosphorus to take place, after which the now coarse grain of the steel must be refined. In rail making it is merely necessary to reheat the bloom before rolling. The grain will be refined during subsequent rolling operations. Fig. 20 illustrates the structure of a rail so treated. Note the uniform phosphorus distribution and the absence of streaked structure.

At this point it would be well to mention a popular fallacy of which one frequently hears; namely, failure through "crystallization" caused by alternating stresses. This is not possible. A fatigue failure is the direct result of the gradual breaking down of the crystal grains.

ANNEALED STEEL CASTINGS

In a recent test of steel castings in which the author participated about forty heats of metal were made. Representative test pieces were taken throughout and specimens were subsequently cut from these for microscopic examination. After etching with picric acid they were classified as to annealing. Figs. 21 to 24 represent respectively bad, poor, fair and good annealing. Fig. 21 shows the well-known cast or Widmanstätten structure typical of all steel before heat-treatment. This structure is weak and brittle, especially under shock, and its elimination is the primary object in the annealing of steel castings. Under static or tensile tests these four classes of structure differ slightly in physical properties, but under shock great differences are readily made manifest. Analyses of these heats were approximately: carbon, 0.25; man-

ganese, 0.69; sulphur, 0.026; phosphorus, 0.019; silicon, 0.045. The results of the tensile tests averaged: yield point, 76,550; elongation, 29 per cent; reduction of area, 46.2 per cent. Under a Frémont drop test with a piece of given cross-section the bad, poor, fair and good annealing gave, respectively, resistance to impact of 2, 12, 15, 16.5 kilogram-meters, which agrees perfectly with what the microstructures would indicate. Fig. 21 shows a very pronounced Widmanstätten structure. Fig. 22 shows this less pronounced. Fig. 23 shows traces of the cast structure. In Fig. 24 it is altogether absent. The need for careful and thorough annealing is here clearly shown, especially in case the material is subject to shock or vibration. The test-bars used in the above were all attached to freight car castings and the differences in structure were readily traceable to variations in the annealing practice.

In concluding the author would say that he has hardly scratched the surface of his subject, but that the explanations and descriptions given are only those which are generally accepted by metallurgists. This paper and the preceding¹ may, therefore, be of value to those who, although more or less interested in the subject, have not either the time or facilities for its study.

Niagara Falls, N. Y.

Newcastle Steel Works Expands

An expenditure of about £3,500,000 has been decided upon by the directors of the Broken Hill Proprietary Co. (Ltd.) of Australia for extensive additions to the present plant at the Newcastle Steel Works, where already 5,000 men are employed. The demands of the commonwealth for adequate supplies of iron and steel for newly established industries as well as increased orders from abroad brought about this decision. Two representatives of this company have been sent to the United States for the purpose of glean information relative to the cost of the required additional machinery, according to advices from Consul General Sammons, of Melbourne. All additions are planned to be completed in two years. Another blast furnace, making four in all, is to be erected, together with the added number of coke ovens required. A byproduct plant will be used in connection with the coke ovens. Other additions include a duplex steel plant, a continuous mill for the rolling of steel bars and billets, a duplication of the present rod mill, and a sulphuric-acid plant for the supply of acid in connection with the production of sulphate of ammonia and for galvanizing.

¹See CHEM. & MET. ENG., vol. 23, No. 24, Dec. 15, 1920, p. 1161.

World's 1920-21 Sugar-Crop Estimates

THE world's sugar-crop estimate for 1920-21 is over 1,700,000 tons greater than the production of 1919-20. While definite advices have been received from many sources, some of the reports are only partial and are subject to adjustment, and it must be understood that in a great many instances there are still two or three months of growing weather that can materially affect the present outlook, says the *Weekly Statistical Trade Journal*. Under such conditions these crop estimates must be looked on as more of an indication than an estimate, but nevertheless they are quite valuable in determining what the prospects of supplies are for the next sugar year.

CANE CROPS—EUROPEAN BEET CROP

As regards Cuba, while the usual inquiries have been sent to the factories, reports are coming in very slowly, due perhaps to the unsettled financial situation there. The centrals hesitate in giving any indication of their probable output until conditions improve. The Cuban weather during the growing season has been favorable in the western half of the island; the eastern half has been lacking somewhat in rainfall. Santa Clara Province was affected by a light rainfall. Increased planting has been reported in a number of sections. Ten or twelve new factories that are either complete or under construction may add something over last year's production. For the present the Cuban crop indication can be placed at 4,000,000 tons.

Santo Domingo and the British West Indies have all been affected by a more or less serious drought during the growing season and in some cases crops are reduced. The weather in Porto Rico has been irregular, but no material change is expected in the production. Formosa and Japan will show increased outputs. Dry weather prevailed in Natal and the Fiji Islands.

Preliminary figures issued several months ago, based on sowings, are not likely to be attained in the European beet crop. Many contributing circumstances have been the cause; partly irregular growing weather, lack of coal, transport materials, labor, etc. The figure for Germany, based on a yield per hectare much below a normal acreage, indicated on the area planted a crop of 1,300,000 tons, but even the low yield per hectare used by us will not be reached, and it is hardly likely that a crop in excess of 1,150,000 tons will be made in that country. Similar conditions obtain in Czechoslovakia; latest official advices from there state the crop would reach only 650,000 tons raw value. France is showing quite an improvement over the preceding crop and will probably have a production of 100,000 tons more than its last one. Spain also shows a material increase.

AMERICAN AND CANADIAN BEET CROPS

Regarding conditions in the United States, the output of the beet crop in Ohio is estimated at 45,000 tons, Michigan at 145,000, Colorado 250,000, Nebraska 75,000, Utah 140,000, Idaho 50,000, and California 151,000. In this last state the campaign is so nearly over that the figure given will be very close to the actual out-turn.

The above estimate is freely confirmed by the United States Government, which estimates the crop of beet roots as of Nov. 1 as 8,812,000 tons. Using an average

yield of the past three years (including last year's poor out-turn), gives a crop indication of 900,000 tons. This year's yield will exceed the three years' average materially, according to present prospects.

According to advices, prospects in Canada are very good, and with the material increase in sowings the indications are that a crop of at least 35,000 tons will be made.

The total indicated world production for 1920-21 of both cane and beet sugar is 17,085,500 tons, against the last campaign of 15,310,824 tons, an increase of 1,774,676 tons. The largest world's production on record was the 1913-14 campaign, when the production totaled 18,667,399 tons.

PRELIMINARY 1920-21 FIGURES

Preliminary estimates (in long tons) for the 1920-21 crop in the various sugar-producing countries of the world and the final estimates for the two previous crops follow:

Countries	1918-19 Tons	1919-20 Tons	1920-21 Tons
United States:			
Louisiana.....	250,802	108,035	175,000
Porto Rico.....	362,618	433,825	435,000
Hawaiian Islands.....	538,913	505,500	525,000
West Indies—Virgin Islands.....	9,000	12,400	5,000
Cuba.....	3,971,776	3,730,077	4,000,000
British West Indies:			
Trinidad.....	47,850	58,416	60,000
Barbados.....	75,271	50,000	50,000
Jamaica.....	43,000	46,875	45,000
Antigua.....	12,841	15,540	13,500
St. Kitts.....	10,901	10,036	8,000
Other British West Indies.....	7,580	5,651	10,000
French West Indies:			
Martinique.....	10,027	22,000	20,000
Guadeloupe.....	26,604	31,000	25,000
Santo Domingo.....	158,309	175,736	189,000
Haiti.....	3,300	5,000	5,000
Mexico.....	70,000	92,000	100,000
Central America:			
Guatemala.....	13,441	15,000	15,000
Other Central America.....	14,240	20,000	20,000
South America:			
Demerara.....	107,560	96,000	100,000
Surinam.....	8,000	12,000	12,000
Venezuela (exports).....	16,970	18,000	20,000
Ecuador.....	7,000	7,000	8,000
Peru.....	300,000	350,000	350,000
Argentina.....	130,266	292,110	225,000
Brazil.....	183,079	177,155	300,000
Total in America.....	6,379,348	6,289,356	6,715,500
British India (consumed locally).....	2,370,000	3,049,157	3,000,000
Java.....	1,749,408	1,335,763	1,515,000
Formosa and Japan.....	415,678	283,482	350,000
Philippine Islands (exports).....	195,289	203,000	200,000
Total in Asia.....	4,730,375	4,871,402	5,065,000
Countries	1918-19 Tons	1919-20 Tons	1920-21 Tons
Australia.....	209,853	175,000	175,000
Fiji Islands.....	80,000	60,000	60,000
Total in Australia and Polynesia.....	289,853	235,000	235,000
Egypt (consumed locally).....	75,899	90,000	80,000
Mauritius.....	252,770	235,490	240,000
Reunion.....	50,000	40,000	40,000
Natal.....	185,000	150,000	160,000
Mozambique.....	20,615	35,000	40,000
Total in Africa.....	584,284	550,490	560,000
Europe:			
Spain.....	6,618	6,048	5,000
Total cane-sugar crops.....	11,990,478	11,952,296	12,580,500
Germany.....	1,324,579	750,000	1,150,000
Czechoslovakia.....	700,000	535,000	650,000
Hungary and Austria.....	110,096	154,444	250,000
France.....	74,183	146,918	225,000
Belgium.....	173,436	238,692	300,000
Netherlands.....	336,616	225,000	175,000
Russia (Ukraine, Poland, etc.).....	127,467	145,000	175,000
Sweden.....	144,600	160,000	165,000
Denmark.....	106,682	182,843	175,000
Italy.....	139,409	81,650	175,000
Spain.....	10,800	8,550	10,000
Switzerland.....	2,441	10,974	10,000
Bulgaria.....			10,000
Rumania.....			10,000
Total in Europe.....	3,250,309	2,689,071	3,520,000
United States.....	674,892	652,957	950,000
Canada.....	22,300	16,500	35,000
Total beet-sugar crops.....	3,947,501	3,358,528	4,505,000
Grand total, cane and beet sugar.....	15,937,979	15,310,824	17,085,500

Refractories for Electric Furnace*

A description of the Properties of Refractory Brick and of the Raw Materials Employed in Their Manufacture, With a Review of the Many Factors Involved in the Efficient Use of Refractories in General

By R. M. HOWE†

BEFORE discussing the subject from a theoretical or practical standpoint the writer wishes to present certain data to be used as a foundation. These data have been gathered from both private and public sources, and acknowledgement is hereby made of the splendid co-operation of individuals interested in this field.

PHYSICAL AND CHEMICAL DATA RAW MATERIALS

There are nine raw materials which are most commonly used in or which are being most seriously considered for use in the manufacture of electric-furnace linings. They are fireclay, silica (or ganister), magnesite, dolomite, chrome, bauxite (and diaspor), zirconite, carborundum and alundum. The last two are mentioned by their trade names, as considerable data are given as applying to these products. Strictly speaking, they are not raw materials, but can be classed as such most advantageously and used to represent this general type of material.

The ranges of analyses given in the accompanying table are believed to be typical of the materials used for refractory purposes.

A discussion of the influences of different impurities must be omitted, as this would be the subject of a paper in itself.

ANALYSES OF REFRACTORY RAW MATERIALS

	Fireclay	Ganister	Magnesite (1)	Dolomite	Chromite (2)	Diaspor and Bauxite (3)	Zirconite (4)	Carborundum (5)
Ignition....	3-16	Up to 5	48-52	42-48	15-31	2-72	.....	.....
Silica.....	40-70	96-99	Up to 5	Up to 4	3-10	4-10	7.74	.....
Alumina....	45-15	Up to 2	Up to 1	Up to 4	14-2	52-72	0.66	Up to 2
Iron oxide..	Up to 5	Up to 2	Up to 5	Up to 4	14-19	2-6	3.10	Up to 1
Lime.....	Up to 0.7	Up to 0.3	Up to 3	27-34	Trace	Trace	.....	Up to 0.3
Magnesia... Up to 0.7	Up to 0.3	40-47	16-20	11-17	Trace	.....	.....	.....
Alkalies....	Up to 2	Up to 0.6	.....	.....	Trace	.....	.....	.....
Zirconia....	.....	.....	.....	.....	.....	84.1	.....	.....
Chromic oxide.....	.....	.....	.....	.....	36-46	.....	.....	.....
Carbon.....	.....	.....	.....	.....	.....	.....	.....	27-30
Silicon.....	.....	.....	.....	.....	.....	.....	.....	65-70
Titania.... Up to 2	Trace	.....	.....	.....	.....	1-5	1.21	.....

(1) McDowell & Howe, *J. Ceram. Soc.* vol. 3, pp. 199, 201 (1920).

(2) MET & CHEM. ENG., vol. 8, p. 107 (1910). *Sprechsaal*, vol. 26, p. 1,075 (1893). Private communications.

(3) MET. & CHEM. ENG., vol. 8, p. 107 (1910). R. Wohlin, *Sprechsaal*, vol. 46, p. 767 (1913). Private communications.

(4) H. C. Meyer, MET. & CHEM. ENG., vol. 13, p. 263 (1915).

(5) Catalog, Carborundum Co. of America.

The refractory bricks or shapes made therefrom have similar analyses. In many cases the difference in composition between the raw material and the finished product is simply due to the removal of carbon dioxide, water or organic matter, but in a few cases it is the

result of the addition of a binder, as for example the lime in silica brick.

PROPERTIES OF REFRACTORY BRICK

Fusion Point.—The fusion points of a number of refractory brick were published by Kanolt¹ in 1912, and as they agree closely with those secured by the writer, Kanolt's results are given herewith. That of zirconia brick has been determined by several investigators, but the results of Arnold² and Ruff³ show the best agreement, being 2,600 deg. C. and 2,563 \pm 10 deg. C. respectively. Fused bauxite, or alundum, fuses at 2,050 deg. C.⁴ Silicon carbide, or carborundum, does not fuse but decomposes at about 2,240 \pm 5 deg. C.

FUSION POINTS OF REFRACTORY BRICK

	Deg. C.
Fireclay.....	1615 to 1715 ¹
Silica.....	1700 to 1705 ¹
Magnesia.....	2165 ¹
Chrome.....	2050 ¹
Bauxite.....	1565 to 1785 ¹
Zirconia.....	2563 ² to 2600 ³
Carborundum, decomposes at.....	2240 ⁵
Alundum.....	2050 ⁴

When the fusion point of refractory material is determined, the results actually show the temperature at which a small piece of the material softens under its own weight. When the influence of pressure, as well as that of high temperatures, is taken into consideration far different results obtain.⁶ Fireclay brick begin to compress slowly at about 1,350 deg. C. when a pressure of 50 lb. per sq.in. is applied. Zirconia brick "squatted" at 1,420 deg. C. and 1,600 deg. C. under pressures of 75 and 25 lb. per sq.in. respectively. Magnesia,

BEHAVIOR OF REFRACTORY BRICK WHEN HEATED UNDER PRESSURE OF 50 LB. PER SQUARE INCH

Kind of Brick	Investigator	Behavior
Fireclay.....	Bleining and Brown....	Softens at about 1,550 deg. C.
Silica.....	Brown, Le Chatelier.....	Rigid at 1,500 deg. C., but probably shears at about 1,600-1,650 deg. C.
Magnesia.....	Brown, Mellor and Emory	Shears at 1,410-1,555 deg. C.
Chrome.....	Brown, Mellor and Emory	Shears at 1,400-1,450 deg. C.
Zirconia.....	Estimated from Mellor and Emory.....	"Squats" at about 1,510 deg. C.
Bauxite.....	W. F. Rochow.....	Softens at about 1,350 deg. C.
Carborundum..	B. C. Lindbarger.....	No signs of failure at 1,650 deg. C. the furnace limit.

chrome and silica brick usually show slight signs of softening under pressure and then suddenly shear. Load tests on bauxite brick showed compressions of from 1.96 to 6.35 per cent⁷ under a pressure of 25 lb. per sq.in. at 1,350 deg. C. after one and one-half hours.

¹C. W. Kanolt, U. S. Bureau of Standards, Tech. Paper 10 (1912).

²H. Arnold, *Chem. Ztg.*, vol. 42, p. 413 (1918).

³Ruff and Lausckke, *Sprechsaal*, vol. 36, p. 70 (1916).

⁴Catalog Norton Co.

⁵Tucker and Lampen, *J. Am. Chem. Soc.*, vol. 28-I, p. 953 (1906).

⁶Mellor and Emory, *Gas J.*, vol. 142, p. 478 (1918). J. H. Brown, *Trans. Am. Ceram. Soc.*, vol. 14, p. 391 (1912). Le Chatelier and Bogitch, *Trans. Am. Inst. Mining Eng.*, vol. 60, p. 134 (1919).

⁷Bleining and Brown, Tech. Paper 7, U. S. Bureau of Standards (1913).

⁸Private communication, W. F. Rochow.

*Paper read before the Columbus meeting of the Electric Furnace Association, Oct. 7, 1920.

†Senior industrial fellow of the Refractories Manufacturers Association, Industrial No. 4, at Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa.

Carborundum brick do not fail at 1,650 deg. C.^a under a pressure of 50 lb. per sq.in. The accompanying table indicates what may be expected of different kinds of refractory brick when heated under a pressure of 50 lb. per sq.in.

SPECIFIC GRAVITY OF REFRACTORY BRICK

The following data, gathered from different sources, illustrate rather clearly how the weight of an installation depends upon the type of bricks used.

Material	Specific Gravity
Fireclay.....	2.65-2.75
Silica.....	2.29-2.44
Magnesia.....	3.44-3.60
Chrome.....	3.90-4.00
Carborundum ^b	3.12-3.20
Bauxite ¹⁰	3.15-3.25
Alundum ¹¹	3.90-4.00
Zirconia ¹²	5.0

The higher values for zirconia, bauxite, chrome, magnesia and fireclay brick generally indicate harder burning, while the specific gravity of silica brick decreases with the intensity of the burn.

ELECTRICAL RESISTIVITY OF REFRACTORY BRICK

It is natural that interest in the electrical resistivity of refractories has increased with the more general application of the electric furnace, yet very little information on the subject is available. Stansfield, MacLeod, and McMahon¹³ have compared the resistivity at high temperatures of silica, Austrian magnesia and chrome brick made in America, and firebrick from Caledonia. Certain data regarding the resistivity of electric furnace products are given in trade catalogs, but otherwise there is very little information available.

ELECTRICAL RESISTIVITY IN OHMS PER C.C.

Temp. Deg. C.	Magnesia Brick ¹⁴	Chrome Brick ¹⁴	Silica Brick ¹⁴	Fire-brick ¹⁴	Carborundum ¹⁵	Alundum ^{16*}
528	.....	.....	.....	21,000	14.6	130
600	.....	.....	.....	17,000	10.9	16 (730 deg. C.)
700	.....	2,800	.....	13,000	7.8	.....
800	.....	760	.....	9,000	5.4	5.3 (892 deg. C.)
900	.....	420	.....	6,600	3.7	1.8 (1,020 deg. C.)
1,000	.....	430	.....	4,400	2.1	.....
1,100	.....	450	.....	2,300	1.3	.....
1,200	.....	410	9,700	1,300	0.96	.....
1,300	6,200	320	2,400	690	0.65	.....
1,400	420	.....	.....	280	.....	.....
1,500	55	.....	710	60	.....	.....
1,550	30	.....	22	.....	.....	.....
1,565	25	.....	18	.....	.....	.....

* Megohms.

SPECIFIC HEATS OF REFRACTORY BRICKS

Aside from the data given by Heyn¹⁷ for silica and magnesia brick, and that given by Mellor¹⁸ for fireclay

SPECIFIC HEATS OF REFRACTORY MATERIALS

Material	At 100 Deg. C.	At 1,000 Deg. C.
Firebrick ¹⁹	0.199	0.253
Silica ¹⁷	0.219	0.298
Magnesia ¹⁷	0.231	0.324
Alundum ¹⁸	0.198	.....
Carborundum ¹⁸	0.186 (31,985 deg.)	.....

brick, little is known regarding this constant. Other investigators¹⁹ have simply reported determination over

^aPrivate communication, A. C. Lindbarger.

^bTrade catalog.

¹⁰Private communication, J. L. Crawford.

¹¹F. A. G. FitzGerald, *MET. & CHEM. ENG.*, vol. 10, p. 129 (1912).

¹²H. C. Meyer, *MET. & CHEM. ENG.*, vol. 12, p. 791 (1914).

¹³Stansfield, MacLeod and McMahon, *Trans. Am. Electrochem. Soc.*, vol. 22, p. 89 (1912).

¹⁴Stansfield, MacLeod and McMahon, *op. cit.*

¹⁵Catalog, the Carborundum Co.

¹⁶Catalog, Norton Co.

¹⁷E. Heyn, *Mitteilungen aus dem Koniglichen Materialprüfungsamt*, vol. 32, p. 180 (1914).

¹⁸Wilson, Holdcroft & Mellor, *Trans. Ceram. Soc. (Eng.)*, vol. 12, p. 279 (1912-13).

¹⁹Trade catalogs of the manufacturers.

a narrow and low temperature range and have apparently disregarded the fact that specific heat increases with the temperature.

THERMAL CONDUCTIVITY OF REFRACTORY BRICK

The thermal conductivity of refractory brick has been determined several times, and in a number of instances remarkable checks have been secured. In nearly every investigation, however, there has been one marked deviation which has been due to the material used. For example, Wologdine²⁰ used a silica brick sample which was not typical of American manufacture and noted a conductivity lower than that of fireclay. In other cases concordant results have been secured except with magnesia brick, a fact which leads one to believe that the samples were not typical of the product used in commercial furnaces for withstanding the action of metal, slag and high temperatures. When these apparent discrepancies are eliminated, the results show rather close agreement, as may be seen in the accompanying table of selected data.

THERMAL CONDUCTIVITY OF REFRACTORY BRICK AT 1,000 DEG. C. IN COLONIES PER CENTIMETER CUBE PER SECOND PER DEG. C.

Observer	Fireclay	Silica	Magnesia	Chrome	Carborundum
Dudley.....	0.0034	0.0042	.....	0.0057	0.0231
Wologdine.....	0.0042	.....	0.0071	.....	.....
Dougill, Hodsman and Cobb.....	0.0040	0.0046	0.0085	.....	.....
Goerens and Gillis.....	.....	.....	0.0080	.....	.....
Average.....	0.0039	0.0044	0.0079	0.0057	0.0231

Zirconia²¹ brick are said to have a very low thermal conductivity. That of silica brick has been observed to increase greatly at 1,050 to 1,100 deg. C.²²

RESISTANCE TO TEMPERATURE CHANGES

Refractory brick and shapes made from fireclay and electric-furnace products are only slightly affected by sudden changes in temperature. Silica, magnesia and chrome brick must be heated very slowly, especially at low temperatures, if spalling is avoided. When once heated, however, any of these bricks will withstand

Material	Fusion Point Deg. C.	Point of Failure Under 50 Lb. per Sq. In. Load, Deg. C.	Thermal Conductivity at 1,000 Deg. C.	Specific Heat at 100 Deg. C.	Resistance to Spalling
Fireclay.....	1,700	1,350-1,400	0.0039	0.199	Good†
Silica.....	1,700	1,600*	0.0044	0.219	Poor†
Magnesia.....	2,165	1,480	0.0079	0.231	Poor†
Chrome.....	2,050	1,425	0.0057	.....	Poor†
Bauxite.....	1,785	1,350	Same as Fireclay	.....	Good†
Zirconia.....	2,575	or more	Low†	.....	.....
Carborundum.....	2,240	1,510†	0.0231	0.198*	Good†
Alundum.....	2,50	Above 1,650	High†	0.186	Good†

* Estimated from known data.

† Average of results with 25 lb. and 75 lb. per sq.in.

‡ Private communications.

considerable variation in temperature if the change is not too sudden. The more important data regarding the thermal properties of the various refractories have been grouped into tabular form for convenience of reference and comparison. In many instances specific data are lacking, so the writer has taken the liberty of supplying relative data or comparative notes to aid in the formulation of conclusions. The specific data represent the average results obtained.

²⁰Boyd Dudley, Jr., *Trans. Am. Electrochem. Soc.*, vol. 27, p. 336 (1915). S. Wologdine, *Electrochem. Met. Ind.*, vol. 7, p. 283 (1909).

²¹Dougill, Hodsman and Cobb, *J. Soc. Chem. Ind.*, vol. 34, p. 469 (1915).

²²Goerens and Gillis, *Ferrum*, vol. 12, p. 1 (1915).

²³C. H. Meyer, *op. cit.*

²⁴E. Heyn, *Mitteilungen aus dem Koniglichen Materialprüfungsamt*, vol. 32, p. 181 (1914).

There is little doubt that the use of fireclay brick for metallurgical purposes is advisable wherever they give satisfaction. They are inexpensive, easy to install, and require less care in handling than any other refractory material. However, it is realized that there are serious limitations to the application of fireclay brick in the electric-furnace industry because of the extremely high temperatures involved. Consequently, it is necessary to secure the most refractory firebrick available for use in the hotter zones, and even then the furnace temperature should not exceed 1,650 deg. C. for any length of time. Since this temperature is very close to the fusion points of the more refractory fireclays, satisfactory service is secured by applying certain precautions which tend to increase the life of any refractory.

PRECAUTIONS AIMING TO INCREASE THE LIFE OF REFRACTORIES

Insulation of any kind should be carefully avoided when fireclay brick are used at their limiting temperatures, for when the heat which is naturally carried away accumulates on the inner hotter surface failure invariably results. Care must be exercised in preventing the accumulation of plant dust on the furnace roof, for it acts as an insulator and sometimes causes failure. It is also advisable to make the ratio between the heating surface and the radiating surface as small as possible in order to secure additional service from the lining. Undoubtedly the use of water cooling plates would be advantageous, as has been demonstrated in the hotter zones of a blast furnace. A refractory block should never be heated from more than one surface, especially when under pressure; the results of this condition are shown by the load tests.

These rules apply to any kind of refractory material.

USE OF SILICA BRICK

When fireclay brick do not give satisfactory service in roofs silica brick are usually installed. They have fusion points which are practically the same as those of the more refractory fireclay brick, but possess other characteristics which favor longer service. They must, however, be heated very slowly, especially at the lower temperatures, because of their tendency to spall. When this precaution is taken and a temperature of over 1,000 deg. C. is maintained, a silica brick roof should give extended service.

When the roof is heated rapidly strains develop, but are often unnoticed because the expansion of the brickwork holds the brick and pieces in place. Upon cooling, however, the brickwork contracts and reduces the pressure on the different parts of the roof, thus allowing the loosened portions to fall into the hearth. It is believed that if the pressure could be maintained during a cooling period spalling would be less pronounced. Upon heating up again it would be necessary to release gradually the pressure to allow for the expansion of the brick, in order to prevent their being crushed.

It has been the writer's experience that the smaller silica shapes spall less readily than the heavier blocks, due probably to the great expansion strains developed in the latter during the heating periods. This fact would favor the use of small standard sizes rather than the larger special shapes.

There are two characteristics possessed by silica brick which are evidently associated with their satisfactory service in roofs. They have a relatively high thermal conductivity, which helps cool the brickwork, and they

are rigid under a pressure of 50 lb. per sq.in. at temperatures within 100 deg. C. of their fusion points. It is believed that these two facts, coupled with the high viscosity of silica, explain why brick of this type can be used at temperatures very close to their actual melting points. Care should therefore be exercised in furnace design and construction to develop the thermal conductivity of the walls to the maximum. Brick made from various sized angular fragments and burned so as to convert a large proportion of the quartzite to tridymite and cristobolite (indicated by a specific gravity of 2.29 to 2.38) usually have the greater strength at high temperatures.

The use of fused silica brick has not been overlooked, and it is doubtful if they would spall. Their cost, however, would hardly be justified, as more refractory electric-furnace products could be prepared at a slightly greater expense.

USE OF MAGNESITE BRICK

Magnesia brick are favored with a high fusion point, thermal conductivity and resistance to the corrosive action of slag and metal. Because of this fact the brick and grains are used extensively in the hearths and bottoms of basic furnaces. They have less desirable characteristics of being subject to spalling and to the chemical action of certain substances. Extreme care must therefore be exercised in the selection, treatment, installation and use of this material.

The magnesite after being burned should contain from 4.0 to 8.5 per cent of ferric oxide, as this impurity facilitates "sintering." When this amount of iron oxide is present and the specific gravity is from 3.44 to 3.60, the product is sure to be well burned, resistant to slaking and will undergo little or no contraction after being installed. Either the grains or the brick made therefrom may be stored indefinitely if protected from water. These characteristics will be affected by the lime content, which, as is generally conceded, should be low. Investigations reported elsewhere have led to the following conclusion regarding the influence of this oxide.

"The magnesite that was lower in lime showed less tendency to slake and higher refractoriness, as well as greater resistance to attack by firebrick and silica brick, and to the action of the corrosive mixture."²²

Dense hard burned magnesia brick have a thermal conductivity higher than that of silica brick and permit only slight slag penetration.

They should be laid dry in order to prevent any possible action with water and should never be exposed to the action of steam,²³ which causes them to disintegrate.

They are attacked by carbon at 1,700 deg. C.²⁴ according to the following reversible equation:



As this action proceeds, a gray or black deposit consisting of an intimate mixture of magnesia and carbon is deposited in the cooler zones. Both silicon and phosphorus also attack magnesite when they are present in the melt, that high in lime being most easily affected.

When the grains are used in the hearth they should be sintered into place in $\frac{1}{2}$ - to 1-in. layers over a foundation of magnesia brick, using a small amount of

²²McDowell and Howe, *Am. Inst. Min. Eng. Bull.* 146, p. 309 (1919). The corrosive mixture contained phosphorus, silica and ferric oxide.

²³R. H. Youngman, *J. Am. Chem. Soc.*, vol. 3, p. 217 (1920).

²⁴O. P. Watts, *Trans. Am. Electrochem. Soc.*, vol. 11, p. 279 (1907). Goodwin and Mailey, *Ibid.*, vol. 9, p. 89 (1906). R. E. Slade, *J. Chem. Soc.*, vol. 93, p. 327 (1908). P. Libean, *Compt. rend.*, vol. 144, p. 799 (1907).

slag as a binder. This practice should result in the formation of the densest structure, one which would be less easily scoured or loosened in patches.

Dolomite is rarely, if ever, used in the manufacture of brick at the present time because of the difficulty encountered in preventing the lime from slaking. Several years ago such brick were made at different European steel plants, but as it was necessary to use them immediately in order to prevent their disintegration they were gradually replaced by magnesia brick.

The use of dolomite in patching and, in a few cases, for building entire bottoms has continued to the present day, probably because of its low initial cost as compared with that of magnesite. Dolomites highest in magnesia and containing about 4 per cent of iron oxide and alumina apparently have the most desirable characteristics; when over 4 per cent is present, especially when accompanied by more than 3 or 4 per cent of silica, the product is less refractory.²⁶

The writer has compared burned dolomites with "treated" dolomites and dead-burned magnesites and drawn the following conclusions:

The magnesites are more resistant to slaking than the dolomites or dolomite preparations, also to the action of the corrosive mixture and that of fireclay and silica. One of the treated dolomites has a slaking tendency so low as to group it with the magnesites; in its resistance to corrosion it compares more closely with the untreated calcined dolomite high in impurities.

The materials highest in impurities and lowest in lime were most resistant to slaking.²⁷

USE OF CHROME, ZIRCONIA, BAUXITE AND OTHER SPECIAL BRICK

Chrome brick have certain desirable characteristics, but are rarely used in electric furnaces. They are favored by a high thermal conductivity, fusion point and resistance to slagging action. On the other hand, they are difficult to bond, the chromic oxide may be reduced to chromium, and this may contaminate the metal being melted.

The use of a layer of chrome brick or of chrome ore has proved to be a very satisfactory method of separating silica and magnesia brick in order to prevent their interaction at high temperatures. It is possible that chrome, because of its insolubility, might be utilized at the slag line either by itself or in conjunction with magnesite. The successful use of chrome might greatly increase the resistance of the lining to the action of the slag, which dissolves the magnesite or dolomite so rapidly.

As far as the writer is aware few zirconia brick, if any, are being used in electric furnaces, although several investigators believe that their use will solve many problems. These opinions are based upon the high fusion point of the pure material, the low conductivity of the brick, and their marked resistance to the solvent action of certain fluxes.

There are numerous commercial disadvantages, however, which must be overcome before the full refractory value of zirconite is developed. The mineral is often badly contaminated with iron oxide and as a result its fusion point is seriously lowered. It also undergoes considerable shrinkage at high temperatures and must therefore be given a severe heat treatment before

installation, in order to prevent shrinkage in service. It is evident that the raw material used in the brick tested by Mellor²⁸ was not properly selected or else it had not been sufficiently burned. Otherwise brick fusing at about 2,474 deg. C. would not have "squatted" at 1,420 deg. C. under a pressure of 75 lb. per sq.in.

Bearing in mind that the influence of impurities and of the incomplete removal of shrinkage will be accelerated by the low thermal conductivity of the brick, it is evident that three things must be accomplished before the full value of zirconite as an electric furnace refractory is realized:

1. Raw material of the necessary purity must be available, either by proper sorting or purification.
2. It must be bonded into a mechanically strong brick.
3. This brick should undergo little shrinkage after being installed.

Very little is published regarding the use of zirconia in binding up furnace bottoms. When its high fusion point and insolubility is considered, this possibility is not remote.

Bauxite brick have characteristics very much the same as those made from zirconite, a fact which is not surprising because of the similarity in behavior of the dominating oxides found in each. In order to secure the full value of bauxite as an electric-furnace refractory it is therefore necessary to subject the brick to an intense heat treatment in order to completely remove the shrinkage. Bauxite brick do not possess the advantage of having a high thermal conductivity.

Carborundum and alundum offer good possibilities for service in roofs, as they have all of the assets of silica brick, with the additional advantage to a low tendency to spall. Their fusion points are high, as is the thermal conductivity. Their tendency to shrink is naturally low, and they can support a heavy load at high temperatures. The writer is unable to state to what extent they are affected by furnace gases or slag. In a few cases oxidation of the silicon carbide to silica, resulting in the weakening of the brick structure, has been reported. It is probable that the practice of insulating bricks of this type could be practiced with greater safety than with other types, because of their higher fusion points and low shrinkage.

CONCLUSIONS

In conclusion, the writer wishes to emphasize certain factors concerning the service secured from refractory brick. They should be protected from rain while being stored in order to prevent the weakening of their structure. They should be laid up with a material similar to the brick themselves, or one which will not corrode or flux them, using as small a joint as possible. The furnace should be constructed so that heat will be conducted away from the hotter portions. The ratio of heating to cooling area should be made as low as possible. Refractory brick or shapes should be heated from one side only in order to keep the heating surface low and in order to avoid the effect of pressure at high temperatures. Insulation lowers the margin of safety and should therefore be avoided, even to the extent of allowing dust to accumulate on the roof. When the furnace is being heated this should be done gradually, especially where magnesite and silica brick are involved. When the furnace is being cooled it should be remembered that cold blasts produce or accelerate spalling.

²⁶M. Zyromski, *Am. Mfr.*, vol. 39, p. 9 (1886).

²⁷McDowell and Howe, *op. cit.*

²⁸Mellor and Emory, *op. cit.*

Adsorption by Silica Gel*—II

Adsorption Efficiencies on Ethyl Ether, Acetone, Benzene, Water and Petroleum Ether Vapors—Experimental Results—Dehydration of Air at Various Saturations—Solvent Recovery†

By E. B. MILLER

CONSIDERABLE losses of valuable solvents such as ether, acetone, alcohol, benzene, etc., occur in a variety of industrial processes. In the recovery of such solvents silica gel will probably find some of its most important applications. The general principles already discussed apply in this field and we can predict approximately the adsorptive power of the gel for the vapor of a particular solvent before determining it experimentally. These general principles have already been illustrated in some detail by experimental data on sulphur dioxide, and it will not be necessary to go into the same detail hereafter.

For the recovery of solvents after they have been adsorbed by the gel the most satisfactory method,

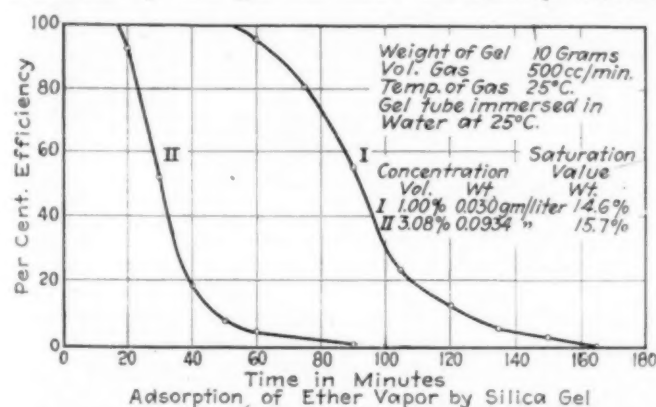


FIG. 6. ADSORPTION EFFICIENCY ON ETHER VAPOR

applicable in nearly all cases, consists in heating the gel to the proper temperature and sending steam directly through it. For the volatile solvents here considered 105 deg. C. is sufficient to bring about rapid distillation from the gel. This method is particularly adapted to the recovery of substances which, like ether, benzene, etc., are but slightly soluble in water and do not react chemically with it.

Steam displacement was used in the laboratory experiments described below. In carrying out an experiment the tube containing 100 g. of gel with its adsorbed material is connected on one side with a source of steam and on the other with a condenser and receiver, the latter being so constructed that its contents may be drawn off and weighed. When all connections are made the gel is heated to about 105 deg. C. by immersion in an oil bath. During heating some of the adsorbed material generally distills out. When the desired temperature is reached steam is admitted to the gel and the mixed vapors are condensed and collected in the receiver.

In reference to the percentage recoveries of the

various solvents as shown in the following pages it should be pointed out that, working on such a small scale, the experimental errors are relatively large. No very special effort was made to eliminate losses in handling and weighing the distillates.

ETHYL ETHER

Fig. 6 gives the results of two typical experiments on the adsorption of ether vapor at 25 deg. C.

The desired mixture of ether vapor and air is obtained by saturating a metered volume of air by bubbling it successively through several bottles of pure ether kept at a constant temperature. The resulting mixture may, if desired, be diluted by further admixture with air. The weight of ether carried by the air is determined by absorbing it completely from a known volume in a weighed portion of silica gel and noting the increase in weight. From the weight of ether in a known volume the volume per cent is calculated on the assumption that the gas laws hold for ether vapor, which is of course only approximately correct.

An examination of the curves show that, using a 1.00

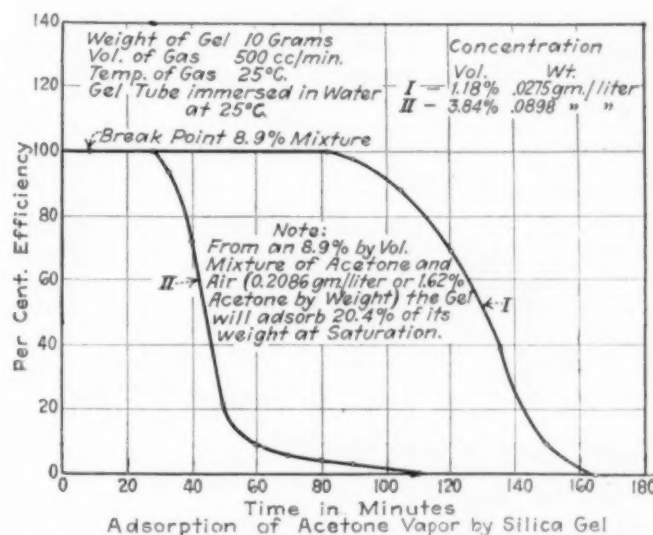


FIG. 7. ADSORPTION EFFICIENCY ON ACETONE VAPOR

per cent mixture of ether vapor and air, the gel adsorbs at 25 deg. C. an amount of ether corresponding to 14.4 per cent of its own weight; and, using a 3.08 per

Experiment 1. 100 g. of gel containing 29 g. of adsorbed ether.	Distillate		
	Ether		Water
	Grams	Per Cent of Total	Grams
During heating to 107 deg. C.	10.209	35.2	None
15 minutes of steaming.	14.376	49.5	0.755
20 minutes of steaming.	None	None	.....
Recovery.....	24.585	84.7	.....

*Paper presented before the American Institute of Chemical Engineers, Montreal, June 28, 1920.

†For Part I see CHEM. & MET. ENG., vol. 23, No. 24, Dec. 15, 1920, p. 1155.

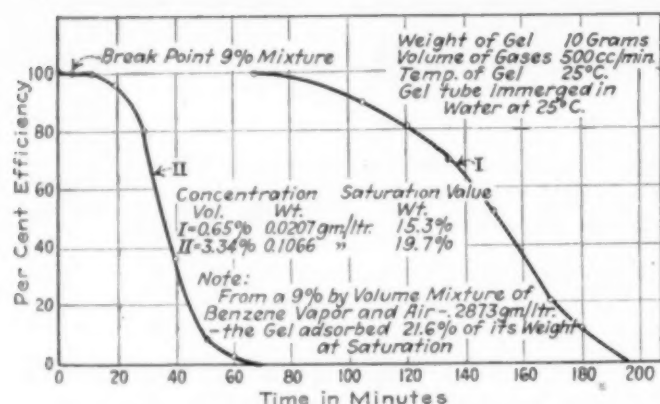


FIG. 8. ADSORPTION EFFICIENCY ON BENZENE VAPOR

cent mixture, it takes up 15.5 per cent of its own weight. In each case it adsorbed nearly 8 per cent of its own weight at 100 per cent efficiency.

Two experiments were carried out under slightly different conditions.

At the end of experiment 1 no ether was left in the gel. The 15 per cent loss was due to evaporation through the vent in the receiver and to experimental

Experiment 2. 100 g. of gel containing 30.5 g. of adsorbed ether.	Distillate		
	Ether		Water
Temperature of condenser, 0 deg. C.	Grams.	Per Cent of Total	Grams
Temperature of receiver, 0 deg. C.			
Receiver vented through a tube containing silica gel.			
During heating to 107 deg. C.	9.769	32	
10 minutes of steaming.	17.821	58.4	17.545
20 minutes of steaming.	None	None	
Recovery.	27.590	90.4	

losses in handling and weighing. We carried out the next experiment using colder water in the condenser in order to minimize the loss by evaporation through the vent in the receiver.

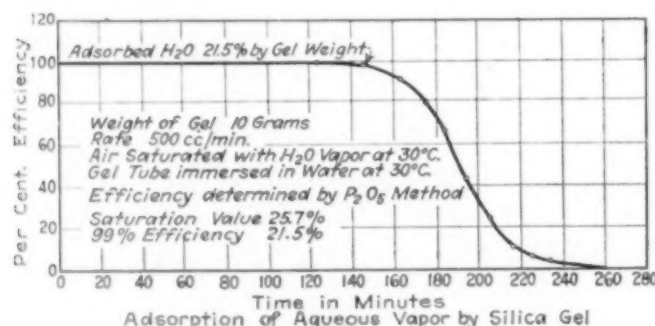


FIG. 9. ADSORPTION EFFICIENCY ON WATER VAPOR

The vent in experiment 2 adsorbed 0.095 g. of ether.

ACETONE

Fig. 7 shows the results of several experiments on the adsorption of acetone vapor at 25 deg. C. from mixtures with air ranging in concentration between 1.18 and 8.9 per cent acetone vapor by volume.

The mixtures with air and analyses of same were made in a manner similar to that already described for ether. The data given on the curve sheet are self-explanatory.

We give here the results of three experiments in the recovery of adsorbed acetone.

Experiment 1. A tube containing 100 g. of gel with 33.8 g. of adsorbed acetone was connected with a source of steam, a condenser and a receiver as already de-

scribed. During the heating some acetone was distilled out and condensed in the receiver, but the amount was not determined separately. When the temperature reached 105 deg. C. steam preheated to 112 deg. C. was passed through the gel for a period of eighty minutes; 94.44 c.c. of condensate was obtained which had a density of 0.94094. This corresponds to 33.77 g. of acetone, or 100 per cent recovery.

Experiment 2. One hundred grams of gel containing 33.3 g. of adsorbed acetone. Temperature of condenser 20 deg. C. Temperature of receiver 0 deg. C. Receiver vented to air.

During heating to 107 deg. C. 8.0485 g. of acetone distilled over. Steam was then passed for twenty minutes, giving a distillate of 16.9726 g., having a density of 0.81529 at 25 deg. C. This corresponds to 15.36 g. of acetone and 1.6126 g. of water.

Further steaming for thirty minutes gave a distillate of 26.69 g., having a density of 0.9770 at 25 deg. C. This corresponds to 3.87 g. acetone and 22.82 g. water.

Acetone recovered was 27.28 g., or 82 per cent of the total.

Experiment 3. One hundred grams of gel containing

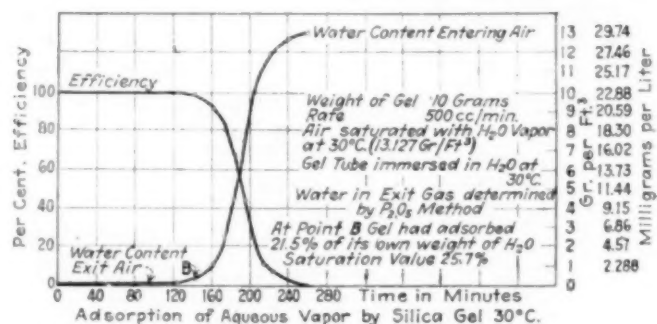


FIG. 9A. DRYING POWER OF SILICA GEL $P/P_o = 1$

33 g. of adsorbed acetone. Temperature of condenser, 0 deg. C. Temperature of receiver, 0 deg. C.

Acetone to the amount of 6.062 g. distilled over during heating to 107 deg. C. Steaming for ten minutes gave a distillate of 34.47 g., having a density of 0.8654 at 25 deg. C. This corresponds to 24.8184 g. of acetone and 9.6516 g. of water. Further steaming gave no liquid acetone.

Acetone recovered, 30.8827 g., or 93.5 per cent of the total. During distillation the receiver was vented through a column of gel. Only a negligible increase in weight occurred.

BENZENE (BENZOL)

Fig. 8 gives the results of some adsorption experi-

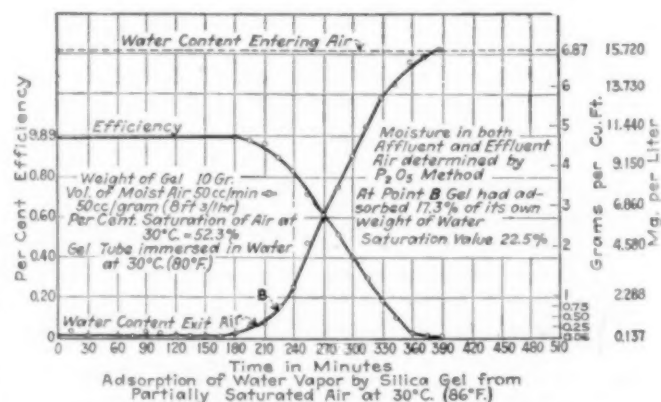
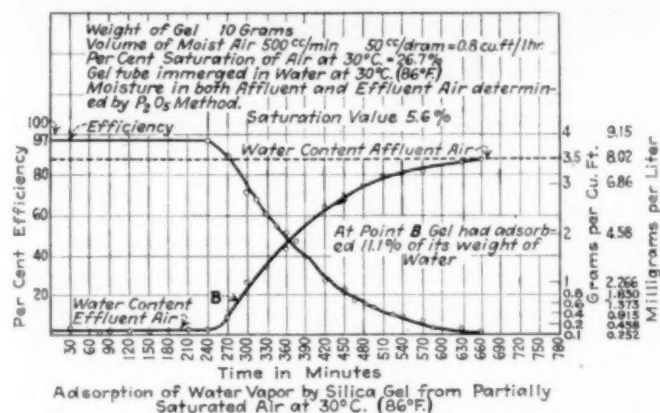


FIG. 9B. DRYING POWER OF SILICA GEL $P/P_o = 0.53$

FIG. 9C. DRYING POWER OF SILICA GEL $P/P_o = 0.267$

ments on benzene. The curves follow very closely the corresponding curves for acetone. Concentrations were determined in the manner already described.

Recovery. Two experiments are given, differing with respect to the temperature of the condenser and the amounts of adsorbed benzene present.

<i>Experiment 1.</i> 100 g. of gel containing 21 g. of benzene. Temperature of condenser, 20 deg. C. Temperature of receiver, 0 deg. C. Receiver vented to air.	Distillate		
	Benzene		Water
	Grams	Per Cent of Total	Grams
	None		None
During heating to 107 deg. C.	17.6282	83.9	4.1755
20 minutes of steaming.	0.5489	2.6	51.5
45 minutes of steaming.			
Recovery.	18.177	86.5	.....
<hr/>			
<i>Experiment 2.</i> 100 g. of gel containing 33.5 g. of adsorbed benzene. Temperature of condenser 0 deg. C. Temperature of receiver, 0 deg. C. Receiver vented through gel.	Distillate		
	Benzene		Water
	Grams	Per Cent of Total	Grams
	None		None
During heating to 107 deg. C.	30.9716	92.1	6.2852
10 minutes of steaming.	1.1515	3.4	54.335
30 minutes of steaming.			
Recovery.	32.123	95.5	.....

WATER

We have seen that silica gel, even after activation, always contains some water. The water content varies between 5 and 7 per cent by weight, depending upon the temperature and time of activation. By prolonged heating in an air stream the water content may be reduced

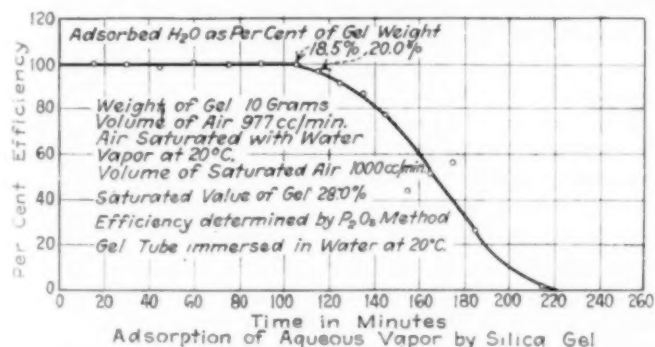


FIG. 10. ADSORPTION EFFICIENCY OF WATER VAPOR

below 5 per cent, but gel with 5 to 7 per cent gives better adsorption. For the sake of clearness in presentation we distinguish between this residual water, always present, and adsorbed water.

Fig. 9 shows the adsorption of water at 30 deg. C. from air saturated at 30 deg. C., using gel with an

initial water content of 7 per cent. The air was passed through the gel at the rate of 50 c.c. per minute per gram of gel, thence over weighed phosphorus pentoxide. The increase in weight of the latter gave the water content of the air dried by the gel. For the first two hours the amount of water in the air as it left the gel tube remained constant at 0.3 mg. per liter, which corresponded to 99 per cent efficiency. In other words, the relative humidity of the air dried by gel was 1 per cent. At the end of two and a half hours the efficiency was still 98 per cent and the gel had adsorbed 21 per cent of its own weight of water. Adsorption continued till the gel had taken up an amount of water corresponding to 25.7 per cent of its own weight, which is here called the saturation value.

Figs. 9-A, 9-B, 9-C show the drying power of silica gel at 30 deg. C. using air with varying amounts of moisture ranging from 100 per cent to 26.7 per cent relative humidity at 30 deg. C.

Fig. 10 shows the adsorption of water at 20 deg. C. from air saturated at 20 deg. C., using a rate of 100 c.c.

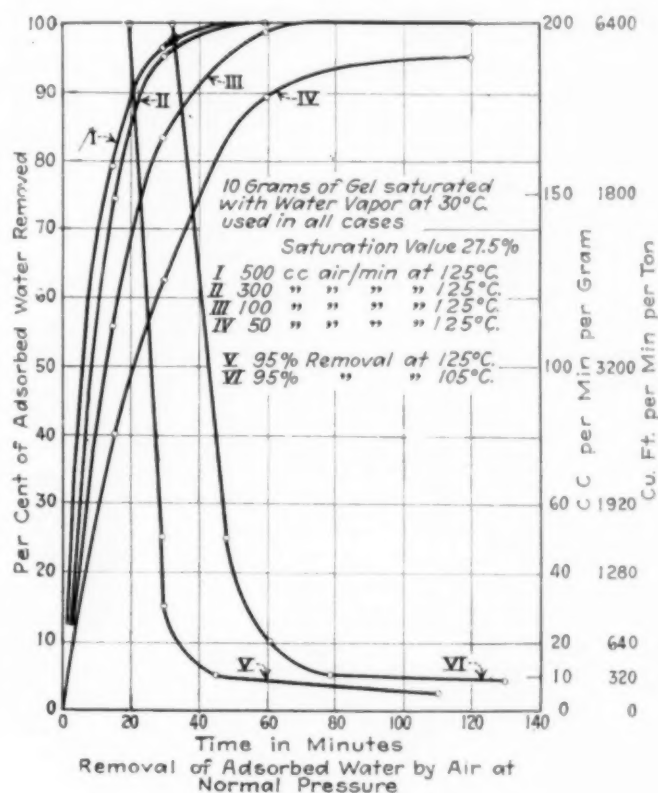


FIG. 11. REMOVAL OF WATER FROM SILICA GEL

per minute per gram of gel. Here again we have 99 per cent efficiency for 105 minutes, at which point the gel had taken up 18.5 per cent of its own weight of water. Saturation value was 28 per cent.

Fig. 11 gives in graphic form a summary of a large number of experiments on the removal of adsorbed water by air displacement. Experiments have shown that at temperatures from 125 to 200 deg. C. the rate of removal is dependent mainly on the volume of air used, and increases only slightly with increase in temperature. We accordingly do not include here work done above 125 deg. C.

Curves I, II, III and IV show the percentages of adsorbed water removed against time for rates of air flow ranging from 5 c.c. to 50 c.c. of air per minute per gram of gel. An examination of Curves III and IV

indicates that the adsorbed water is removed about as rapidly with air at 30 c.c. per minute as with 50 c.c. per minute.

Curves V and VI show the same experimental results in which the rate of air flow is plotted against the time necessary to remove 95 per cent of the adsorbed water at 125 deg. C. and 105 deg. C. respectively. An inspection of these two curves will make clear that at these temperatures little will be gained by increasing the rate much above 20 or 30 c.c. per min. per g. of gel.

GASOLINE

The results of two laboratory experiments at 25 deg. C. are given in Fig. 12. The mixtures of air and gasoline were made in the usual way. The decrease in con-

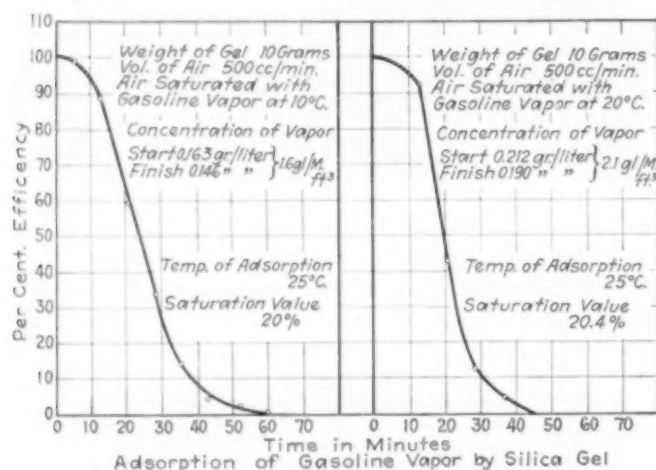


FIG. 12. ADSORPTION EFFICIENCY OF GASOLINE

centration of gasoline vapor during each experiment was, of course, due to the removal of the more volatile constituents from the gasoline used to saturate the air.

In order to make the tests on recovery of gasoline as rigorous as possible we used in the experiments here described not ordinary gasoline, but petroleum ether, which contains only the lower boiling constituents of gasoline. The hydrocarbon vapors were introduced into the gel in the usual way, viz., by bubbling air repeatedly through petroleum ether at 23 to 25 deg. C. and leading the air thus saturated over the gel kept at the same temperature. For recovery the same procedure was followed as has already been described for other solvents.

Experiment 1. 100 g. of gel containing 15 g. of adsorbed material. Temperature of condenser, 20 deg. C. Temperature of receiver, 0 deg. C. Receiver vented to the air.	Distillate		
	Petroleum Ether	Water	
	Grams	Per Cent of Total	Grams
During heating to 107 deg. C.	1.1387	7.5	None
10 minutes of steaming.	11.1815	74.5	3.6555
20 minutes of steaming.	0.401	2.7	11.2215
Recovery.	12.721	84.7	.....

Experiment 2. 100 g. of gel containing 24.7 g. adsorbed material. Temperature of condenser, 0 deg. C. Temperature of receiver, 0 deg. C. Receiver vented to air.	Distillate		
	Petroleum Ether	Water	
	Grams	Per Cent of Total	Grams
During heating to 107 deg. C.	5.104	20.6	None
10 minutes of steaming.	18.2625	73.9	11.329
20 minutes of steaming.	None	.....	.....
Recovery.	23.3665	94.5	.....

The vent of tube absorbed 0.1018 g. of petroleum ether during distillation.

(Part III will appear in a subsequent issue.)

Legal Notes

BY WELLINGTON GUSTIN

Liability for Loss in Shipment Due to Leakage

The Supreme Judicial Court of Massachusetts has affirmed the judgments against the Florida Cotton Oil Co. in its suits against the Clyde S. S. Co. and the Maine Coast Co. The defendants were sued as common carriers to recover for the loss of 458 gal. of cottonseed oil, being part of a shipment of 100 bbl. of the oil.

The Florida company delivered to the Clyde S. S. Co. at Jacksonville, Fla., 100 bbl. of oil to be transported under a bill of lading to Machiasport, Me., for the Machiasport Packing Co. The oil arrived on Sept. 10 in Boston, where the barrels were transferred on the day of arrival to the Maine company, which forwarded the oil in two shipments, one on Sept. 12 and the other on Sept. 16, to Machiasport, where it was found there had been a loss of 458 gal. The oil had been received at Jacksonville in barrels which "were new six-hoop, white oak, hand-made barrels well coopered, made of well-seasoned timber and were tested" thoroughly before being used.

The Clyde company defended on the ground that when it delivered the oil to the Maine company no leakage had occurred, and under the eighth clause of the bill of lading, that "no carrier shall be liable for loss or damage not occurring on its portion of the route, nor after said property is ready for delivery to consignee, . . . it is not responsible if any loss thereafter occurred." It also contended that under the exemption clauses, that no carrier shall be liable for damages caused by leakage, chafing or loss in weight, it is not liable, because the Florida company failed to offer any negligence from which negligence can be found.

RULE OF LAW WELL SETTLED

The court cited the rule laid down in another case, as follows:

"The law is well settled in this commonwealth and in most of the United States that a corporation established for the transportation of goods for hire between certain points and receiving goods directed to a more distant place is not responsible beyond the end of its own line, as a common carrier, but only as a forwarder, unless it makes a positive agreement extending its liability."

The Supreme Court said that while the shipment was an interstate shipment and under the act of Congress commonly called the Carmack amendment the initial carrier, where the shipment is by rail, or partly by rail and partly by water, is made liable for a loss upon the line of a connecting carrier even if the property had been received under a bill of lading restricting the initial carrier's liability to loss upon its own line, the transportation in the present case having been entirely by water, the initial carrier is not liable for loss on the line of a connecting carrier, except under common law rules.

The first and second provisions of the bill of lading agreed that negligence should not be presumed against the carrier, as is presumed under the common law; and further "no carrier or party in possession of all or

any of the property herein described shall be liable for any loss thereof or damages thereto by causes beyond its control . . . or by leakage, breakage, chafing, loss in weight, decay, vermin, changes in weather, heat loss or wet."

But the court held that though just and reasonable conditions may be imposed limiting the common law liability of a carrier, he cannot be relieved when the goods are lost or destroyed during carriage through his own negligence or the negligence of his servants or agents, though the contract of shipment may exonerate him in its terms. And a provision exempting the carrier from loss by leakage is reasonable.

The Florida company introduced no evidence other than leakage as the cause of the loss. Now the responsibility of the terminal carrier is the same as that of the initial carrier. The Maine company took the oil under the bill of lading issued by the initial carrier, and any valid limitation therein inured to its own benefit. Since the provision against liability by leakage was valid, the Florida company to recover must prove that the leakage was caused by the active negligence of the carrier. This it failed to do, and judgment was affirmed against it.

Logan Patent for Creosoting Apparatus Held Not Infringed

The Logan patent, No. 836,592, for creosoting apparatus as limited by the prior art, has been held by the United States Circuit Court of Appeals, Ninth Circuit, not infringed in the suit brought by Logan and the National Lumber & Creosoting Co. against J. H. Baxter and W. H. Jordan.

The object of the Logan invention is to provide means for treating with preserving fluids the butt ends of poles used for telephone, telegraph, electric lights, etc., by what is known as the hot and cold process. The apparatus presents three vats, into one of which the poles to be treated are placed on end upon bars which are arranged between heating coils. Above the treating vat is a reservoir tank, from which creosote or other fluid runs by gravity through a pipe and a valve. Below the treating vat is a relief tank, into which hot fluid from the treating tank is suddenly discharged by gravity through a large pipe. In operation, as soon as the hot creosote is discharged, cold creosote is let immediately into the treating vat to complete the treatment.

The status of the prior art runs back to a patent No. 391 issued to August Gotthieff in 1837. Various patents cover every element of the Logan claim, says the court, except means for the sudden removal of hot fluid from the treating vat.

The apparatus of Baxter and Jordan is operated by heating the preserving fluid in the treating vat after the poles are inserted, afterward withdrawing the heat, the fluid remaining and being allowed to cool, the poles remaining in the single bath twenty-four hours. In view of the prior art the court says the scope of the Logan patent is limited to the apparatus described in claim 2 of his patent, that being a treating vat fitted with a small pipe to introduce fluid from a supply tank, and a large pipe to permit sudden and immediate discharge by gravity of the hot fluid into another tank, so that cold fluid may be immediately introduced into the treating tank for completing the process of impregnation. The apparatus of Baxter and Jordan has no means by which creosote may be immediately withdrawn from the treating vat into a relief tank. Their cylin-

der placed below the treating vat has no such office, and without adjustment it could not be so used. These differences, the court said, avoided infringement.

A decree for Baxter and Jordan was affirmed.

Chemical Company Liable for Deaths of Boys Bathing in Poisonous Abandoned Pool

The responsibility of a manufacturing plant for its vacated premises is the controversy involved in an action of Van Britt against the United Zinc & Chemical Co., decided in the United States Circuit Court of Appeals of the Eighth Circuit.

The facts involved show the chemical company owned and operated at Iola, Kan., a plant at which it manufactured sulphuric acid and zinc spelter. In 1910 it tore down the buildings on the premises, moved the machinery and wreckage away, and since then has not occupied or used the land for any purpose. There was a basement containing acid tanks with lead pipes in and out under what was known as the tower building, and when it was torn down chemical refuse was thrown into the open basement. As the tanks and pipes were taken out some sulphuric acid got into the basement. Other chemical refuse was left about on the surface, and the old basement later became a pool of clear water from surface drainage, strongly impregnated with sulphuric acid and zinc sulphate. The vacant property covers about twenty acres and is located on the outskirts of the town.

In 1916 Van Britt and family were traveling overland and camped for a few days not far from the pool. His two boys, eight and eleven years old, in passing it one afternoon, responded to boyish impulses and went in bathing. A short time after going in the younger was dead in the pool, the older was taken out, removed to a hospital and died two days later "from swelling of the bronchial tubes, and gastro-intestinal irritation, irritation of the stomach and bowels, which produced an inflammation of the bowels and stomach." He had colicky pains, vomiting and gasping for breath. Both deaths were attributed by experts to the poisonous chemicals in the water which had been taken internally. The water, when so taken, caused an immediate burning in the throat and choking; and applied outwardly it caused itching and slight sense of burning.

Van Britt brought action for damages against the chemical company, charging that it carelessly and negligently left the pool of poisonous water open and exposed, and without inclosure, barrier, danger signals or warnings of any kind about it, that it maintained the poisonous pool and failed to fill it up.

The general principle of law is that no one may use his property to the injury of another. The court says there is a conflict in the decisions as to the extent and under what conditions this rule may be carried against one as a basis for liability on account of injuries to children resulting from dangerous attractions which he places upon or suffers to continue on his premises. The application is made more freely where the thing complained of is put to no useful, ornamental or other purpose of enjoyment.

Where the inclosure around a tract of land formerly used for manufacturing purposes had fallen away, so that the public were free to go at will and had made footpaths across it, if a pool of water impregnated with poisonous chemicals was attractive to boyish instincts and impulses as a place to go in bathing, and boys yielding to such impulses were killed by the poisons, it was immaterial whether the boys saw or could see

the pool before they entered upon the tract, said the court. The law does not class children of tender years with idlers, licensees or trespassers upon the property.

Further it was said that where a manufacturing plant had been abandoned and dismantled, and the inclosure had fallen away, so that the public crossed the premises at will, the law imputed knowledge and consent to such use to the owner. And where boys, who responded to the desire to go bathing, were killed by the poisonous chemicals, the owner's liability and amount of damage were questions of fact for the jury.

In another case the court said: "The occupant or owner of premises who invites, either expressly or impliedly, others to come upon them, owes to them the duty of using reasonable and ordinary diligence to the end that they be not necessarily or unreasonably exposed to danger; and an implied invitation to another to enter upon or occupy premises arises from the conduct of the parties, and from the owner's knowledge, actual or imputed, that the general use of his premises has given rise to the belief on the part of the users thereof that he consents thereto."

Judgment against the chemical company for the wrongful deaths was affirmed in the Court of Appeals.

Bills of Lading Construed in Light of Contemplated Adventure

In a suit by W. R. Grace & Co. against Frank Waterhouse & Co. to recover damages for injury to goods caused by the delay in transportation thereof from Hongkong to San Francisco, the United States Circuit Court of Appeals has affirmed the lower court's judgment in dismissing the suit, and holding that bills of lading are to be construed in the light of the nature and details of the adventure which was contemplated by the parties.

The merchandise involved was carried by the steamship from Hongkong to Seattle and there discharged and placed in a warehouse. It was delayed there two months by a stevedores' strike, and when forwarded by the Waterhouse company to its destination at San Francisco it was found damaged as a result of the delay in Seattle.

The court said that facts and oral evidence were admissible to explain ambiguity and to show the circumstances of the execution of the contract. Facts which were not inconsistent with the terms of the bill of lading might be adverted to to make clear what was not clear in the contract.

Again, a steamship bill of lading, providing for carriage of the products to the port of San Francisco and for delivery "there" to order, or at the vessel's tackles to another carrier on the route to destination, if consigned beyond a port of call, and by the connecting carrier to be transported into the port of San Francisco, did not restrict delivery to another carrier to such delivery at San Francisco, but, where San Francisco was not a port of call, authorized such delivery at another port.

And a steamship bill of lading providing for carriage to the port of San Francisco, to be there delivered unto order or at the vessel's tackles to another carrier, and referring to a condition on the back thereof which provided that the goods might be transshipped at any port, and for that purpose might be stored in bulk or craft, or landed, authorized the landing of the goods at Seattle for the purpose of transshipment to San Francisco, which was not a port of call.

Weir Measurement of Liquids

BY L. G. CHASE

THERE are many reasons for close and accurate measurement of all the elements entering into the manufacture of various products under present-day conditions. While production costs are at present decreasing somewhat in certain fields, there is little chance of great reductions for years to come. In modern industrial plants, with their complex departmental systems of supply from one central source or stockroom, it is necessary, to secure accurate records of production costs, that the amount of liquids used in the various processes be carefully measured. These liquids are usually handled in such quantities that it is not possible actually to weigh them and due to their corrosive and

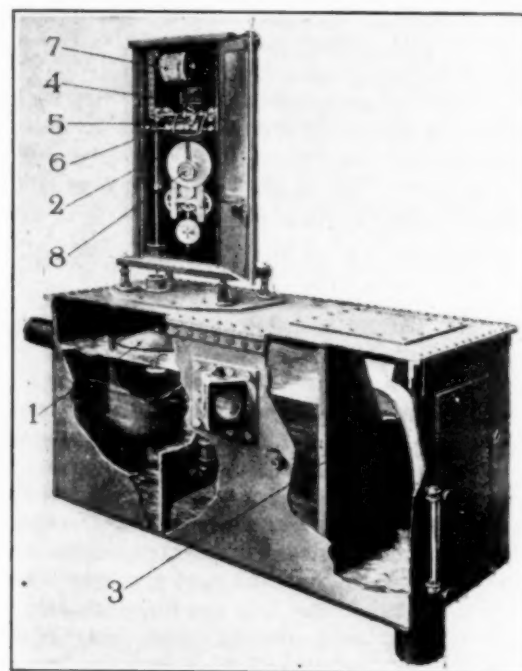


FIG. 1. GRAVITY FLOW METER

Operation: Float 1 raises or lowers rackrod 2, indicating on scale 4 height of liquid flowing over V-notch 3. Drum 5 connected by pinion 6 with rackrod 2 indicates rate of flow at any moment in pounds or gallons per hour. Twenty-four-hour chart 7 records flows graphically. Cumulative readings are shown by integrator 8.

chemical action in most cases they cannot be measured by any ordinary type of meter.

For instance, meters which involve the principle of measuring the velocity of the liquid flowing in closed lines cannot be used at all in most cases, because they depend on a mercury valve to compensate for the differential or velocity head. Most chemicals would combine with this mercury in some form or the working parts of the mechanism coming in contact with the liquid could not be made of such material as would withstand the chemical action. Displacement meters would come under this same head. There is left for us, then, only the weir type of meter. This particular type has one disadvantage—it can be used only where gravity flow conditions are possible, but such a condition can usually be arranged for in services such as those contemplated.

V-NOTCH TYPE WEIR

The weir type meter exists in many forms, but the V-notch type has been found to be the best adapted for accurate measurements of the relatively small volumes which would obtain. The formula of the V-notch was

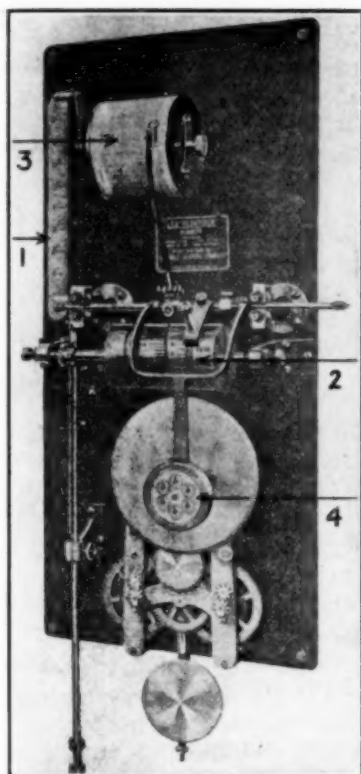


FIG. 2. LEA RECORDER

1. Measuring the height of water flowing over the weir. 2. Cam drum giving instantaneous indications of the rate of flow. 3. Graphic recorder. 4. Integrator.

same proportionately for any height over the notch, and therefore a fixed constant can be used. This is the constant which Thompson determined. Of course, the flow of liquid over any gravity weir is proportional to the area times the velocity times a constant. The area of a right-angled notch is equal to the square of the height. The velocity is of course equal to the square root of $2GH$ where H is the height. The square root of $2G$ can be combined with the constant due to any contractions, and we therefore have the foundation of the formula, the quantity equals a constant times H^2 into the square root of H , or a constant times $H^{3/2}$.

With the weir or V-notch type meter, it is possible to have all parts in actual contact with the liquid made out of materials which are not subject to chemical action. For instance, in the measurement of sulphuric acid, a wooden measuring tank can be provided with a sheet lead lining and the float rod and notch plate can be made of glass. For the measurement of caustic liquors, steel can be used throughout. If it is desired to measure milk or substances of like nature, which require extreme cleanliness, measuring tanks, notch plates and

derived by Prof. James Thompson about sixty years ago. Recent exhaustive experiments have served only to prove his high engineering ability and the extreme accuracy with which he worked. The formula he derived is as follows: Q , the quantity of liquid in cubic feet per minute, equals $0.305H^{3/2}$ where H is the height in inches of the liquid passing over a right-angled V-notch. This formula is also true for a notch of any angle less than a right angle in direct proportion to the area. In the ordinary weir the constant used varies as to whether there are any contractions or not and also varies due to the friction of the water passing over the bottom of the notch. It has been found for the V-notch that the resulting friction forces are the

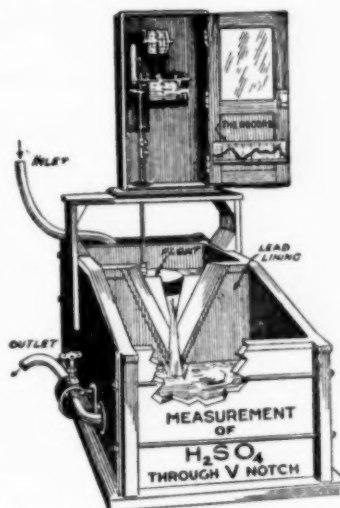


FIG. 4. SULPHURIC ACID METER

with this cut. The recording mechanism, which is shown in Fig. 2, furnishes four kinds of information: First, the height in inches of water flowing over the weir. Second, it gives instantaneous indication of the rate of flow. This is suitably inscribed on the cam drum, cut of which is shown in Fig. 3. Third, a graphic paper record is given in pounds or gallons of liquid during any part of a 24-hr. period. Fourth, the integrator shows the total volume flowing between two different readings. In order to check the accuracy of the machine at any instant, it is necessary only to ascertain the height of the liquid actually passing over the notch, from the scale. Knowing this height, it is a simple operation to work out the formula as determined by Prof. Thompson and check the results as shown by the recorder. The cam

all other elements in contact with the liquid can be tinned. Monel is also largely used in making parts to resist the action of various chemicals.

THE LEA RECORDER

We will now briefly describe a commercial type of V-notch meter to show its simplicity and adaptability for this service. Fig. 1 shows the standard type of gravity flow meter for the measurement of any liquid not corrosive to steel. The various parts of the instrument and their uses are briefly described in connection

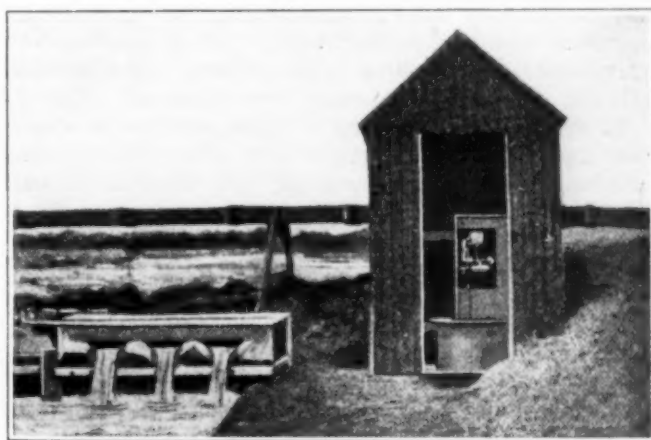


FIG. 5. GAGE HOUSE FOR BLEACHERY

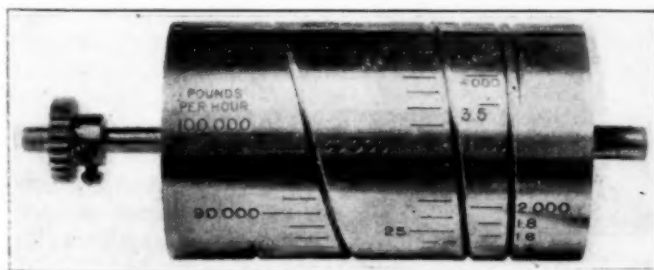


FIG. 3. CAM DRUM

drum, shown in Fig. 3, has suitably inscribed on it the curve of flow worked out from the $\frac{3}{2}$ power of the head, so that the chart is uniformly divided and equal increments of pen movement on the paper record actual values in volume. This permits the use of any standard type of planimeter in checking the charts.

The integrating device shown in Fig. 2 is driven by a powerful double-spring Seth Thomas pendulum clock. The aluminum disk on which the integrator friction wheel rides is driven by this clock at a speed of two revolutions per hour. The disk is 6 in. in diameter. The integrator and planimeter reading of the chart can be checked within $\frac{1}{2}$ of 1 per cent.

Fig. 4 shows an instrument specially designed for the measurement of sulphuric acid and Fig. 5 an outfit of this kind applied to the measurement of trade waste from a bleachery.

A recording thermometer can be attached to these instruments in such a way that a continuous record can be made of both the quantity and the temperature of the liquid on one chart.

Special propositions, of course, can be worked out for special cases. Measurement of such liquids as sulphuric acid, caustic solution, pyroligneous acid, cyanide, coconut oil, etc., is handled successfully in actual practice.

Philadelphia, Pa.

Repairing Lips and Bottoms of Steel Ladles

Owing to the nature of the smelting process followed at the Nickelton, Ont., plant of the British American Nickel Corporation, the slag obtained sometimes runs high in matte, the action of which is very destructive to steel ladles, tending to wash away the steel at the point of contact and injure the vessel beyond further practical usefulness.

The company has recently been getting economical reclamation by means of thermit welding. The accompanying illustrations and sketches give an idea as to the work done. Pieces of steel were forged and welded to the kettle rather than completely filling up the burnt areas with thermit steel. By this method undue contraction strains were minimized.

In the case of the kettle with the holes in the bottom three forged steel patches and two thermit applications were made as shown in Figs. 1 and 2, owing to the irregularity of the holes and the facility of making two welds easier than one irregular patch. The welding of the bottom was spread over two operations, owing to the fact that there was insufficient material on hand to complete the job the first time. In lining up the patches approximately 1 in. was provided at the edges for the entrance later of thermit steel. These patches were surrounded by a yellow wax pattern and the usual thermit welding practice was then followed.

In arranging riser patterns these patterns were used both inside and outside, one coming off at the high point and two others placed about half way down on the wax. The latter two served to take care of the shrinkage of metal when the weld started to cool.

In the case of welds made on the sides of ladles or kettles (Fig. 3) care must be taken not to put too much stock in the collar of the weld, otherwise there would be a tendency to retard the cleaning or "skulling" of the kettle. In applying the wax collar the wax should be from $\frac{1}{2}$ in. to $\frac{3}{4}$ in. fuller than finished shape in order to allow for shrinkage during contraction.

In forging the lip patch the blacksmiths followed the



FIG. 1. PATCHES IN PLACE BEFORE APPLICATION OF WAX COLLAR



FIG. 3. SHOWING THE LIP BURNT AWAY BY HOT MATTE

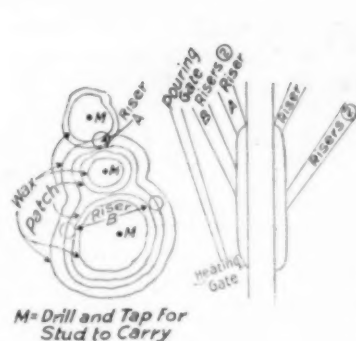


FIG. 2. METHOD OF WELDING KETTLE BOTTOM

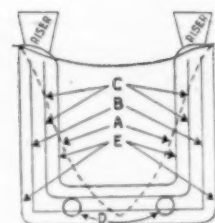


FIG. 4. METHOD OF WELDING PATCHED KETTLE LIP

outline of the cut material, cutting and shaping it to provide a space of about 1 in. between patch and original metal. It is believed that for repairs of this kind time can be saved by cutting away the kettle to a square shape as shown in Fig. 4. The lower portion will not then lend itself readily to melting down during the preheating operation. It may also be preferable to cast the lips of steel rather than forge them. Fig. 5 shows a welded lip, before gates or risers were cut away, and with the sides of the mold box still in place.

New Trenching Machine

Construction companies or plant managers contemplating new plants or additions to present properties will note with interest the new multipedal trencher of the Austin Machinery Corporation of Chicago shown herewith. This machine is designed after the fashion of military tractors to operate through heavy friction clutches on each side, to turn practically within its own radius and to be operated by one man. It is particularly applicable to plant work where new pipe lines are being run underground.

A crew hoist raises and lowers the digging arm automatically, and the endless chain and buckets are of standard type. This hoist also acts effectively, because of its construction, as a lever to force the buckets to dig, by crowding the bucket line against the face of the ditch or cut.

A cleaning device takes care of the sticky dirt and scrapes out each bucket as it passes a point at the head of the excavator boom, directly over the conveyor belt. This can be adjusted to deliver the excavated material to either side of the machine.

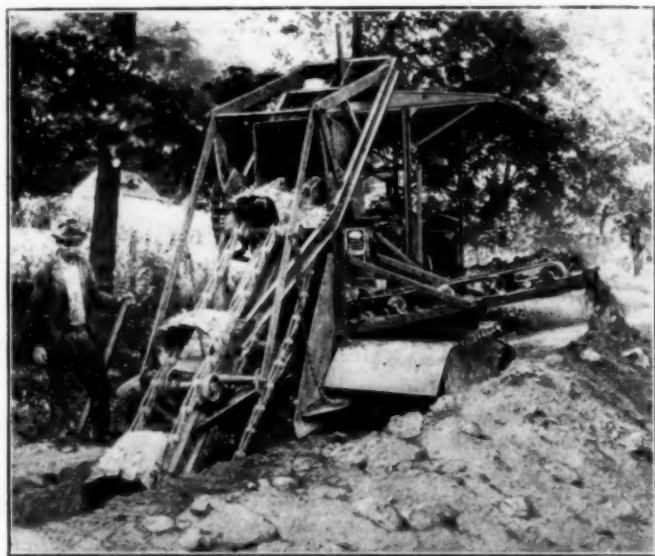
The gasoline engine is of four cyl. four cycle type, cooled by an inclosed radiator.

The digging width, with 18-in. buckets, will run from 20 in. to 28½ in. and with 24-in. buckets from 26½ in. to 29 in. The standard boom will dig up to 6 ft. in depth, although the machine is substantial for service



FIG. 5. WELDED LIP BEFORE REMOVING RISERS AND POURING GATE

with an extensive equipment for digging 8 ft. deep. The traction accommodates itself to irregular surfaces, as the equipment consists of two oscillating multipedals. Each one of these multipedal tractions is driven independently by a friction clutch, so that in turning in a confined space one may be stopped while the other is going ahead, turning the machine practically within its own length.



MULTIPEDAL TRENCHING MACHINE

The conveyor belt is reversible, so that it can deliver dirt on either side. Adjustable screws are provided for taking up the slack.

An important feature of the working performances is its easy interchangeability for digging trenches with vertical banks or small ditches with sloping sides.

Synopsis of Recent Chemical & Metallurgical Literature

Unknown Points in Rail Manufacture.—C. W. GENNET, JR., of the firm of Robert W. Hunt Co., read an interesting paper before the Western Society of Engineers, Chicago, Nov. 18, 1920, in which he asked the following pertinent questions, which must sooner or later be answered, most probably in large part by metallurgists—that is to say, men interested in quality in metal:

1. Are rails made of steel by the continuous Talbot furnace process comparable with those made by the straight open-hearth method? In the continuous process the furnace is seldom emptied by a hundred tons or so of steel and is tapped every two hours, as against the ten hours of time required to make an equivalent heat in a regular furnace. Is the steel from the rapid-working Talbot furnace sufficiently free from oxides and other impurities to afford good, sound rails?

2. How can such a matter be quickly proved?

3. What effect, if any, on rails has steel made by the duplex process, wherein highly oxidized metal is added to the open-hearth furnace, sometimes very soon before tapping?

4. How can rails rolled from steel containing excessive amounts of impurities be detected?

5. What effect on rails is produced by recarburizing the steel in the ladle with coal or coke and then adding cold deoxidizers to the ladle?

6. What is the real effect produced by holding a ladle of steel prior to casting the ingots to permit time for the chemical reactions to settle?

7. What is the effect on rails rolled from ingots cast with running stoppers and sometimes without any

control by the ladle operator? How does the size of the nozzle, pouring temperatures and time required to cast the ingots of a heat influence rails?

8. How soon after casting ingots should they be charged into the soaking pits in order to assure a minimum of piping and segregation? What effects are produced by delays in promptly charging the ingots to the pits, and what is the effect of unduly and rapidly chilling the outside or skin of the ingots?

9. How long a time and under what conditions of gas and air regulation should ingots remain in the soaking pits? What kind of control of the pits is best to insure against overheating or burning the ingots?

10. What is the effect of rolling rails from ingots one side of which has been heated so hot as to show a bright white spot significant of overheating?

11. What effect on rails have different rates of blooming the ingots? In some cases 8 x 8-in. blooms are made from ingots in nine passes and in other cases in twenty passes. Some mills work rapidly and others slowly; does this produce any difference?

12. What effect on the grain structure or the life of rails is produced by increasing the number of passes, or work given to the steel, when the ingots are rolled into rails? One mill makes a rail from a 19-in. square ingot in fifteen passes, while another mill makes the same rail from a 24-in. square ingot in twenty-nine passes. Has the average rate of reduction per pass any effect on the life of rails?

13. What matters mostly influence the production of rails showing seams on the surface? Some heats are practically free from indications of seams, while on other heats rolled at the same time seams are abundant.

Photography of Colored and Distant Objects.—In his first address as president to the London Section of the Society of Chemical Industry, Sir WILLIAM J. POPE discussed the photography of colored and distant objects. His address is printed in full in the Nov. 15 issue of the society's journal. In demonstrating the value of a spectroscopically pure red filter between the lens and a distant object to bring out greater detail, he availed himself of a familiar phenomenon with happy facility.

"The atmosphere," he said, "is not penetrated with equal facility by light of all colors or of all wave lengths. The rays of short wave length, the blue and violet, are most readily absorbed and diffused by the air, and, in passing from short to longer wave lengths, through the green and yellow to the red, the absorptive and diffusing effect of the atmosphere becomes progressively less and less.

"A simple demonstration of the truth of this statement is presented to us every day. When the sun is high it appears white or bluish-white, and its outline is sharp; but as the sun declines it appears yellow and loses its sharpness of definition. Just before the sun falls below the horizon it is bright red and shows a hazy outline. So that with perpendicular incidence the sun's light reaches us with but little absorption of the blue rays by the short lengths of atmosphere through which it has to pass. As the sun declines the blue is absorbed by the longer stretch of air, and just at the setting the atmospheric path through which the sun's rays reach us is so long that the blue, green and yellow are absorbed and diffused and nothing reaches us but the red light. The same thing happens in a fog; if the fog is slight the sun appears yellow and not sharply

defined, but if the fog is dense the sun shows red, and its circle is very indistinctly defined.

"These facts, based upon common observations, have a very important bearing. If a distant view is photographed on an ordinary plate sensitive only to the blue and violet, absorption and diffusion of the light are considerable; the resulting photograph is thus more or less ill-defined. But since the atmosphere is penetrated to a far greater extent by the red rays, it follows that if a spectroscopically pure red filter is placed between the lens and the object, the resulting photograph will reveal far more detail."

Intercrystalline Fracture in Mild Steel.—WALTER ROSENHAIN and D. HANSON, of the National Physical Laboratory, presented a brief note on the above subject before the British Iron and Steel Institute, Sept. 21, 1920. Investigations of several hundred fractures in mild steel convince them that fracture (except at very high temperatures) is by breakage across the ferrite crystals rather than between them. They now describe four noteworthy failures which are mainly intercrystalline, three from high-pressure steam boilers, and one from a tube in intermittent service in hot niter.

Case I (0.14 C) was from the combustion chamber of a marine boiler, showing severe cracking at the edges between rivet-holes, associated with low elastic limit, elongation and impact. The cementite was collected in thin layers at the boundaries of ferrite crystals. Normal results were obtained in all tests from the central part of the plate.

Case II (a boiler drum) cracked around the edges, starting from rivet-holes. Physical properties, edge to center, were little different, and the microstructure showed only part of the cementite as intercrystalline films; yet the cracks seemed to be most numerous in those portions of the plate containing the most free cementite.

Case III. Cracks in all plates, but especially the outside cover, in a boiler seam. Physical and microscopic tests revealed no abnormality. Sheared rivets (almost carbon-free) from the same joint also showed intercrystalline cracking. A piece of the sound plate was torn apart, but this fracture went across the grains—intercrystalline weakness appears to be associated with stresses operating for a period of years rather than minutes.

Case IV developed in mild steel tubing after six months' intermittent service without working stress in a niter bath at 300 deg. C. These cracks were badly corroded. Microstructure exhibited globular cementite, often noted in cold-drawn steel tubing annealed several times below the critical range.

This last failure is similar to season cracking, since only internal stresses are in operation. The three failures in boiler plates can hardly be ascribed to stresses set up during bending; forcing a fit seems a more likely source of serious internal stresses. All cases occurred after long-continued heating—a prerequisite for this type of failure in steel as far as present information goes. Corrosion is a subsidiary cause and an accelerator, selectively attacking the intercrystalline cement and therefore weakening cohesion. Proper normalization of structure by proper heat-treatment does not seem to prevent intercrystalline failure, since Case III showed no microscopic abnormality, other than a banded arrangement of the pearlitic areas—if this can be regarded as an abnormality.

Recent Chemical & Metallurgical Patents

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Utilizing Vegetable Refuse.—Refuse from fruit and vegetables, such as pea and bean pods, banana skins, and especially asparagus waste, is treated to obtain fibers suitable for spinning, food or flavoring material, and manure. The waste is crushed with water between rollers and then placed, with the extracted juice and water sufficient to cover it, in an autoclave, where it is heated under pressure for between two and three hours. The fibers are then strained free from the juice and again passed between rollers. They can then be dried and used for coarse weaving, ropes, etc., or they may be boiled with an alkali for two or three hours, washed, pressed and dried, when they are suitable for finer fabrics. The solid residue can be used for manure, either as it is, or after drying and neutralizing the alkali. The liquor is evaporated to any desired consistency, or to dryness, and can be used for making vegetable-soup cubes, seasonings, sauces and the like. (Br. Pat. 147,833, not yet accepted; W. MATZKA, Brunswick, Germany, Oct. 13, 1920.)

Aluminum Alloys.—Aluminum is alloyed with lithium, which may be partly or wholly replaced by barium or strontium, with or without the addition of other metals such as copper, zinc, manganese, tin, etc. The alloy may contain up to 40 per cent of lithium, and may be annealed one or more times by heating to over 100 deg. C. and cooling in air or liquid, or otherwise. (Br. Pat. 147,903, not yet accepted; METALLBANK UND METALLURGISCHE GES., Frankfurt-on-Main, Oct. 13, 1920.)

Molding Cellulose Acetate.—Relates to the production of molded articles from cellulose acetate and consists in subjecting the material in a finely divided state, preferably in the presence of very small amounts of low-boiling or volatile substances, to a high pressure at a temperature approaching the decomposition point and allowing to cool under pressure. The operation may be carried out at a lower temperature and pressure by adding 2 to 5 per cent of water, alcohol, etc., or solid substances such as naphthalene or camphor. Preferably the material obtained by a first pressure is disintegrated and subjected to a second pressing operation. In this case, the cooling under pressure may be omitted by providing the mold with channels, nozzles or slots of small diameter, through which the hot material is forced under pressure in the form of filaments or ribbons. The disintegrated material may be mixed with large quantities of mineral powders—e.g., two to five times the amount of cellulose acetate—before applying the final pressure. The material may be molded with inlays of wood, ebonite, etc. (Br. Pat. 147,904, not yet accepted; CELLONWERKE A. EICHENGRUN, Berlin, Oct. 13, 1920.)

Fatty Acids.—The unsaturated aliphatic hydrocarbons contained in mineral oils or the liquid or gaseous products of their distillation or cracking, in natural

gas, in the liquid or gaseous products of the destructive distillation of coal, wood, peat, shale, shale oils or tar oils, or in carburetted water-gas, oil-gas, water-gas tar, oil-gas tar, lignite tar, producer gas, coal-gas, etc., are converted into fatty acids by first treating the gases, oils, etc., with mineral acids (sulphuric, hydrochloric, etc.) whereby the unsaturated hydrocarbons are converted into esters, and then treating these esters with oxidizing agents. For example, the acid sludge or acid resins obtained in refining mineral oils with sulphuric acid are treated with potassium bichromate and sulphuric acid. Volatile fatty acids formed are distilled off with steam, and the non-volatile fatty acids remaining are freed from chromium oxide by boiling with dilute acid and may be converted into soaps by alkali. Acid anhydrides may be formed in the oxidation process, these also being converted into soaps by alkali. The more volatile acids (butyric, valeric, etc.) may be converted into esters for use in perfumery. (Br. Pat. 147,905, not yet accepted; H. STRACHE, Vienna, Oct. 13, 1920.)

Ethylene Chloride.—The ethylene content of coal-gas, or other gases produced by the distillation of carbonaceous matter, such as lignite, oils, etc., is utilized for the production of ethylene chloride by treating the gases with chlorine in the presence of a suitable catalyst, and separating the ethylene chloride from the treated gas by liquefaction by compressing, cooling, etc. (Br. Pat. 147,909, not yet accepted; GOLDSCHMIDT AKT. GES., Essen, and F. BERGIUS, Berlin, Oct. 13, 1920.)

Cuprous Oxide.—Cuprous oxide is obtained by blowing air through liquid refined copper until the desired stage of oxidation is effected. The cooled material may be ground; it is suitable for the production of copper salts and cuprammonia solutions. (Br. Pat. 147,958—1919; HÜTTENWERK NIEDERSCHÖNEWEIDE AKT. GES. VORM. J. F. GINSBERG, Berlin, Oct. 13, 1920.)

Catalysts for Hydrogenating Fats and Oils.—Non-pyrophoric metal catalysts adapted for use in the hydrogenation of fats and oils are prepared by precipitating a solution of a salt of a catalytic metal with a solution containing a usual precipitant such as soda or caustic alkali, together with borax, and then reducing the precipitate in a current of hydrogen. In examples, a solution of nickel chloride is precipitated with a solution containing soda and borax so as to give a precipitate of nickel carbonate and borate, which is afterward dried, heated to decompose the carbonate and then reduced in hydrogen; a solution of protoxide of nickel dissolved in hydrochloric acid is mixed with kieselguhr, and precipitated with a solution containing soda and borax, and the precipitate then reduced as usual; a cobalt salt solution is mixed with kieselguhr and precipitated with a solution containing a usual precipitating agent and borax, and the precipitate is washed, dried and reduced in hydrogen. (Br. Pat. 148,111, not yet accepted; MÜLLER SPEISEFELTFABRIK AKT. GES., Neukolln, near Berlin, Oct. 13, 1920.)

Extracting Alkali-Metals.—Alkali-metals are obtained by heating a halogen salt of the metal with an alkaline-earth compound such as a carbide, hydride or silicide. For example, a mixture of sodium chloride and calcium carbide may be heated in a vacuum first to 350 deg. C. and afterward to 800 deg. C., whereupon sodium distills to the colder parts of the apparatus. A

high-quality lampblack is formed as a byproduct. (Br. Pat. 148,122, not yet accepted; L. HACKSPILL and C. STAEHLING, Institut de Chimie, Strasbourg, Oct. 13, 1920.)

Wood Preservative.—Mercuric chloride solution is rendered more effective as a wood preservative by mixing with it a solution of a fluorine salt such as sodium fluoride, a fluosilicate or a mixture of fluorine compounds with fluosilicates. The specification states that the mercuric chloride is converted into complex salts. The salt solutions may be applied separately to the wood. (Br. Pat. 148,137, not yet accepted; F. BUB, Petershagen, near Berlin, Oct. 13, 1920.)

Synthetic Tanning Agents.—Synthetic tanning agents are prepared by sulphonating the alkali-soluble fractions of anthracene oil or soft pitch, and condensing the sulphonic acids with aromatic sulphochlorides in alkaline solution. According to an example, the parent substance is sulphonated with sulphuric acid monohydrate, the product dissolved in water and neutralized with caustic soda, sodium sulphate is removed by evaporation, and the concentrated solution is mixed with caustic soda and treated with toluene sulphochloride in benzene solution. (Br. Pat. 148,268, not yet accepted; M. MELAMID, Freiburg, Breslau, Oct. 20, 1920.)

Anthraquinone Derivatives.—A vat dye, giving claret-red shades, is obtained by condensing hydrozine or a salt thereof with 1-amino-anthraquinone-2-aldehyde or the azomethine compounds thereof. The parent azomethine compounds are obtained by heating 1-amino-2-methylantraquinone with aromatic nitro compounds and alkalis, with or without the addition of primary aromatic amines; 1-aminoanthraquinone-2-aldehyde results on hydrolyzing these azomethine compounds by acids. (Br. Pat. 148,339, not yet accepted; L. CASSELLA GES., Frankfurt-on-Main, Oct. 20, 1920.)

Vulcanizing India Rubber.—India rubber is vulcanized in an atmosphere of volatile alkali at atmospheric pressure. The alkali may be ammonia or a volatile organic alkali, and it may be diluted with an inert or reducing gas or a mixture of these, such as hydrosulphuric acid and carbonic acid. The addition of litharge is thus rendered unnecessary, and the color of mixings preserved. The temperature of vulcanization may be about 145 deg. C. (Br. Pat. 148,349, not yet accepted; E. TILCHE, Paris. See also 148,350, Oct. 20, 1920.)

Obtaining Liquid Products From Coal.—In obtaining liquid products from coal by hydrogenation under pressure coal is used which contains not more than 85 per cent of carbon referred to dry substance free from ash. In an example 5 kilos of coal having a carbon content of 74.48 per cent on the above basis was mixed with 10 kilos tar oil and heated for six hours under a pressure of 100 atm. of hydrogen; 87 per cent of the coal was converted into liquid products, as against 11 per cent of a coal with a carbon content of 92.1 per cent similarly treated. (Br. Pat. 148,436, not yet accepted; F. BERGIUS, Berlin, Oct. 20, 1920.)

Ferrochromium.—Ferrochromium, low in carbon or in carbon and silicon, is made by transferring molten high-carbon ferrochromium from a blast furnace into a converter, which may be acid-lined, and blowing therein with or without the addition of lime or other basic materials, or the injection of steam or other gas or vapor into the blast. (Br. Pat. 148,456, not yet accepted; F. KRUPP AKT. GES., Essen, Oct. 20, 1920.)

Current Events

in the Chemical and Metallurgical Industries

Isopropyl Alcohol From Petroleum

A meeting of unusual interest was held by the New Jersey Chemical Society at Stetters' Restaurant, Newark, Monday evening, Dec. 13. C. L. Bryden, chairman of the committee on membership, reported twenty-seven new applicants. These were duly elected, bringing the membership to a total of nearly 550. A petition to Congress urging immediate action on the dye bill was drawn up and Williams Haynes, publisher of *Drug and Chemical Markets*, was called upon to discuss the status of the bill. In pointing out the danger of Germany dumping dyes in this country he called attention to the situation in regard to potassium bromide. The pre-war price of this chemical was 30c. per lb. American-made bromide is now being sold for 45c. per lb., but the Germans are offering it at 20c. for spot, with future delivery as low as 15c.

ARTISTIC PAINTING

Maximilian Toch delivered an entertaining and instructive address on pigments and paints used in ancient and modern artistic painting, including a discussion of the methods used in determining the genuineness of an old painting.

INSTITUTE OF CHEMISTRY PROPOSED

A report of the committee on an Institute of Chemistry was read by the chairman, who said that the tentative plan had been prepared in order to get opinions from all interested. The matter had been brought to the attention of several, but the publication of the report would reach a much larger number. The ideas of the committee were open to changes and suggestions, considerable interest had been shown, and it seemed best to set forth a definite scheme, which would be a basis for a further report.

In answer to several questions the chairman said that there seemed to be no one of the ten or more professional societies which either could or would undertake this matter, but that an offer to do so would be welcome. One very definite suggestion has already been made, that the project for the State of New Jersey be undertaken by the New Jersey Chemical Society. As far as the list making, which was the first step, was concerned, this was already under way; the next step, that of registration, would be considered by the committee. The further suggestion that probable vacancies in the chemical industries be reported to the Society, which would then bring them to the attention of unemployed members, would also be considered.

The report of the committee follows, and the views of all who are interested will be welcome:

At the October meeting of the New Jersey Chemical Society a paper was read which pointed out the need of a closer affiliation among chemists, and it was resolved that a committee be appointed to take action to ascertain if it is advisable to form an American Institute of Chemistry.

Such an organization could:

1. LIST, on request, and without charge: (a) all persons who wished to be considered chemists, in any sense of the word; (b) all chemical products; (c) all chemical industries, these lists to be public.

2. REGISTER any chemist who would furnish a certain amount of definite, accurate information as to education and experience, such information and all other pertinent facts to be subject to independent investigation and to be available to inquirers under reasonable regulations. For registration a moderate fee would be charged.

3. CERTIFY chemists of various kinds of chemical education and experience after the candidate had passed a definite examination suited to the grade of certificate desired. For these examinations reasonable fees would be charged.

4. LEGALIZE the practice of chemistry in its various grades, by securing the proper legislation in national and state legislatures.

5. CO-OPERATE with all institutions training chemists in order to harmonize courses of instruction, and with institutions and chemical societies to interest employers in properly trained chemists, without, however, acting as an employment agency.

Such an Institute of Chemistry would, in the first instance, consist of a self-perpetuating body of, say, fifty chemists, nominated by the existing chemical organizations, with the understanding that after five years one-half the vacancies would be filled from the certified chemists, after ten years all vacancies would be so filled.

We would be glad to have your definite opinion upon the following:

Should an Institute of Chemistry be established?

If so:

Should it function as outlined?

What else, if anything, should it do?

Should it be constituted as outlined?

How should it be financed?

If not, should anything be done?

If so, what?

Replies should be addressed to F. D. Crane, 74 N Willow St., Montclair, N. J.

ISOPROPYL ALCOHOL FROM PETROLEUM

Carleton Ellis, president of the Society, was introduced by Dr. R. P. Calvert, who took this opportunity to tell the members of Mr. Ellis' work on paint and varnish removers, hydrogenation of oils, recovery of potash from silicate rocks, and the preparation of cumarone resins, which are so extensively used in chewing gum manufacture. Mr. Ellis spoke on the development of his process for producing isopropyl and other alcohols from petroleum.

To make petroleum the raw material for a series of chemical products has been the aim of scores of research chemists. Chlorine has been the reagent employed in many cases to attack members of the paraffine series. Thus, chloropentane serves as an intermediate for the production of amyl alcohol by saponification, or for the production of amyl acetate by treating with sodium acetate in an autoclave. One of the difficulties has been to limit chlorination to the desired compound.

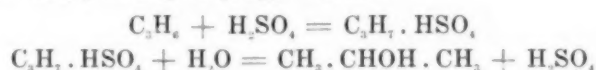
In the manufacture of gasoline by cracking processes many unsaturated compounds are formed and the gases which escape from the pressure stills are found to contain 2 to 3 per cent ethylene, about 5 per cent propylene, and 1 per cent of higher olefines, such as butylene, amylene, hexylene and heptylene. About 1 per cent of H₂S is usually present, although this may be higher when Mexican oils are being treated. Ordinarily these gases are simply used as fuel. One refinery produces over 10,000,000 cu.ft. per day, containing 10 to 12 per cent olefines.

Research on the utilization of the olefine content of these gases was started in the hope of finding a fusel oil substitute. After much experimentation it was

found that isopropyl alcohol could be obtained. An organization, the Melco Chemical Co., was formed for development work and a small plant was built near the Bayonne plant of the Tide Water Oil Co., which furnished the gases from its pressure stills. Later the Standard Oil Co. of New Jersey secured the rights to the process and is now producing isopropyl alcohol under the name of petrohol at its Bay Way refinery. M. D. Mann, Jr., of the company's chemical products division, is in charge.

MANUFACTURE OF ISOPROPYL ALCOHOL

The process depends upon the reaction between propylene and sulphuric acid to form propyl hydrogen sulphate, which hydrolyzes upon boiling the diluted solution, yielding isopropyl alcohol:



Removing hydrogen sulphide and water vapor from the gases constitutes the first step. The olefine vapors are then absorbed in 87 per cent H_2SO_4 (sp.gr. 1.8), the temperature being maintained between 15 and 20 deg. C. by refrigeration. Strength of acid and temperature must be controlled within narrow limits if the formation of tarry polymerization products is to be avoided. At the end of the reaction the specific gravity has fallen to 1.4 and there has been an 80 per cent increase in volume. Unabsorbed gases are used for fuel.

Any oil which may have been entrained in the acid solution is removed in settling tanks. About four volumes of water are added, reducing the strength of the acid to about 15 per cent H_2SO_4 . This separates the tarry polymers.

Hydrolysis is completed and the alcohol separated by distillation in lead-lined stills. During distillation olefines are regenerated, sometimes to the extent of 20 per cent of the amount originally absorbed. These are returned for re-absorption.

The crude product is a mixture of several alcohols (with small amounts of ethers) and is, therefore, rectified to give isopropyl alcohol and several byproducts.

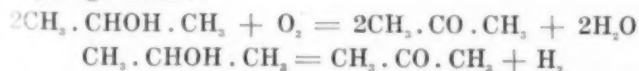
PROPERTIES OF ISOPROPYL ALCOHOL

A comparison of the properties of isopropyl alcohol and ethyl alcohol indicates the close relationship between these compounds:

	Isopropyl Alcohol	Ethyl Alcohol
	Constant Boiling Mixture	
Boiling point, deg. C.....	80.37	78.15
Per cent by volume.....	90.3	97.3
Specific gravity	0.8190	0.8060
	Pure Compound (Absolute)	
Boiling point, deg. C.....	82.44	78.30
Specific gravity	0.7855	0.7893

Petrohol is the constant boiling mixture containing 90.3 per cent by volume of isopropyl alcohol and boiling at 80.2 deg. C. It may be used in place of ethyl alcohol for solvent purposes. It is not suitable for beverage purposes and is thus not subject to Government restriction. Physiological tests indicate that inhalation of the vapors produces less harmful results than ethyl alcohol or methanol.

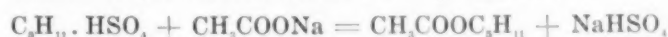
During the war all possible sources of acetone were investigated. It was found that acetone could be made from isopropyl alcohol by catalytic oxidation or by dehydrogenation:



The Bureau of Aircraft Production took over the

plant for a time and prepared acetone by the first method, using copper as a catalyst.

Isopropyl acetate has been produced by a process similar to the direct method for amyl acetate:



No attempt is being made at present to recover the ethylene in the still gases, since the formation of ethyl hydrogen sulphate requires higher temperature and more concentrated acid, which cause excessive polymerization.

Motor Fuel Symposium at the Meeting of the Washington, D. C., Section, A. C. S.

Four prominent speakers and an extended discussion aroused a great deal of interest at the 312th meeting of the Chemical Society of Washington Thursday, Dec 9, when the entire program was devoted to a symposium upon the present status and future prospects of motor fuel supply.

A. W. Ambrose, chief petroleum technologist of the Bureau of Mines, discussed petroleum products for motor fuel supply. He described the three classes of investigators of this subject as pessimists, optimists and super-optimists. The pessimist believes the problems cannot be solved; the super-optimist believes there is no problem. Neither of these classes is right, in Mr. Ambrose's opinion. The optimist believes that there is a problem of difficulty, but that it can be solved by proper planning.

The present gasoline requirements of the country indicate a need for 4 to 4.5 billion gallons of motor fuel for 1921. This represents many times the demand of ten years ago, but the crude oil available from domestic production is only about twice that of ten years ago. The output of motor fuel has been increased from petroleum by better recovery of crude, by higher percentage recovery of motor fuel during refining and by conservation in use of fuel. Efficiency on the part of the ultimate user is the most promising means of relief of the shortage.

Shale oil development, still in its infancy as a commercial business, offers little encouragement for the immediate present because of the difficulty of economical retorting to secure an easily refinable product for motor fuel production.

W. M. Rile of The Barrett Co. discussed the subject of coal-tar products as a source of motor fuel, especially motor benzene. This is really a mixture of benzene, toluene and xylene. Typical specifications for motor benzene are 0.878 specific gravity, neutral reaction, sulphur not exceeding $\frac{1}{4}$ per cent, ability to pass the "doctor" test and the gumming test, and distillation as follows: first drop 79 to 80 deg. C., 60 per cent below 100 deg. C., 90 per cent below 121 deg. C., dry at 135 deg. C., with no appreciable residue. Because of the greater vapor tension at a given temperature and materially higher heating value of benzene per gallon as compared with gasoline, distinct advantages in the way of thermal efficiency and miles per gallon are experienced. However, under present conditions the total available motor benzene supply of the country even if all light oil from byproduct coking and city gas plants equipped for light oil recovery be included, is barely $2\frac{1}{2}$ per cent of the gasoline requirements of the country. By extreme measures, including byproduct recovery from all coal coked, stripping of all city gas supplies for light oil and other increases to be expected during the next few years

in these lines, we cannot expect much over 5 to 10 per cent of the gasoline demand of today to be met from motor benzene as this term is now used.

Industrial alcohol as a motor fuel was discussed by B. R. Tunison, of the Industrial Alcohol Co. The present output of this product which might conceivably be diverted into motor fuel use if the requirements for solvent and chemical operations were ignored is approximately the same order of magnitude as the total available motor benzene. The estimated industrial alcohol plant capacity of the entire country is only about 100 million gallons per year—that is, about 2½ per cent of the motor fuel requirement of today.

The carburetion characteristics of alcohol, benzene and gasoline were contrasted by Dr. Tunison, and it was shown why the blended fuels including some of each of these three constituents could be expected to give superior motor performance. The great advantage of alcohol for motor use is that it fires quickly but does not increase its rate of burning as much during combustion as do the other motor fuels. Moreover the range of fuel: air ratio for successful operation is wider with alcohol than with either benzene or gasoline. Alcohol also permits much higher compression ratios, thus giving large possible increase in efficiency under the most favorable conditions, but it is not under normal circumstances best applied alone. It lends itself rather to the blended fuel application.

Forest products as a source of alcohol for motor fuel was discussed by a paper prepared by E. C. Sherrard, of the U. S. Forest Products Laboratory, presented by Dr. H. F. Betts, of the Forest Service. The possibilities of alcohol production from wood waste were fully set forth. It was pointed out that this was one of the most promising sources of cheap raw material for industrial alcohol production. The estimates indicated that about 15 gal. of alcohol could be expected under ordinary conditions of plant operation per ton of wood treated. The investigations of the Laboratory on the best conditions for cooking wood pulp with acid as the initial stage in alcohol production were discussed also in this paper.

The discussion brought out by questions and contributions from numerous members of the Society emphasized many of the economic aspects of the case, particularly the difficulty of control of living reagents such as the bacteria for fermentation, the necessity for utilization of some sugar-containing waste materials for feeding stuffs instead of for alcohol production, and the severe limitation of any alcohol production if waste materials are not cheaply available. The advantages of coal as a raw material for liquid fuel manufacture and the necessity of adapting the engine to available fuels rather than insisting that fuels must be made to suit present-day engines was also stressed.

Connecticut Valley Branch of T.A.P.P.I. Holds Meeting

The regular monthly meeting of the Connecticut Valley Branch of the Technical Association of the Pulp and Paper Industry was held in the Social Rooms of the American Writing Paper Co., Holyoke, Mass., on Dec. 13. It was in the nature of an experience meeting, the members bringing their troubles along for discussion. Among the topics presented were the presence of beater gum, the intensification of colors in paper after standing around for a short time, slack sizing on one side of machine-finished paper and standard practice of beating.

December Meeting of Connecticut Valley Section, A.C.S.

The regular monthly meeting of the Connecticut Valley Section, A.C.S., was held at the Highland Hotel, Springfield, Mass., on Dec. 11. After dinner and a short business meeting, Prof. Harold Hibbert of the Sheffield Scientific School, Yale University, spoke on "The Constitution of Cellulose." Much of the subject matter of Professor Hibbert's lecture has already appeared in abstract form in *CHEMICAL & METALLURGICAL ENGINEERING* (Sept. 22, 1920; vol. 23, p. 563). In addition, the lecturer discussed the recent work, particularly that of Hess, that has been published since he read his paper at the Chicago meeting of the A.C.S. The address proved to be very interesting, especially to the large number of paper-makers present, and provoked a discussion that lasted about forty-five minutes, much of which was devoted to colloid chemistry.

Patent Bill in Conference

The Patent Office bill with its Senate amendment providing for the administration of Government-employee patents by the Federal Trade Commission has reached the conference stage. There was some opposition on the part of a few members of the House in allowing the measure to go to conference on the plea that the salary increases in the Patent Office are not justified. None opposed the bill on the ground that it contained the Senate amendment. The conferees on the part of the House are Representatives Nolan, the chairman of the committee; Mr. Lampert of Wisconsin and Mr. Davis of Tennessee. The conferees on the part of the Senate will be Mr. Norris, the chairman of the committee; Mr. Brandegee of Connecticut and Mr. Kirby of Arkansas.

Tariff Hearings to Be Held

The tariff schedule covering chemicals, oils and paints is to be the subject of a hearing before the Committee on Ways and Means of the House of Representatives on Jan. 6, 7 and 8. In order that a tariff bill may be ready to be introduced at the opening of the extra session, the Committee on Ways and Means intends to complete the hearings and draft the bill between now and the opening of the session. The hearings on earthenware, earthenware and glassware will be held Jan. 10 and 11. The schedule covering metals will be the subject of hearings on Jan. 12, 13 and 14. Hearings on the sugar schedule are set for Jan. 18 and 19. The hearing at which the free list will be taken up is scheduled for Feb. 11, 12 and 14.

To Study Federal Reorganization

The resolution providing for the appointment of a joint Congressional committee to study the departmental machinery with the idea of recommending a form of reorganization is at this writing in the hands of the President, awaiting signature or veto. The House on Dec. 14 passed the resolution which had been adopted by the Senate at the last session. This allowed its immediate transmittal to the White House. Should this resolution become a law, it will be regarded as a distinct advantage for those favoring the creation of the Department of Public Works. As the committee likely to be chosen is expected to report its recommendations soon, it is believed that this will improve the chances of securing action on a reorganization bill.

Standardization of Industrial Laboratory Apparatus

Through the efforts of certain apparatus manufacturers, there met informally at the Chemists' Club, New York City, on Aug. 2, representatives of the following companies to discuss the advisability of drawing up standard specifications for laboratory apparatus to be used in their industrial research and works control laboratories: Barrett Co., General Chemical Co., Atmospheric Nitrogen Corporation, Grasselli Chemical Co., National Aniline & Chemical Co., New Jersey Zinc Co., Solvay Process Co., Standard Oil Company of New Jersey, and E. I. du Pont de Nemours & Co.

It developed at this meeting that material savings might be expected to develop from this work. Since most of these companies are members of the Manufacturing Chemists Association of the United States, a committee composed of these members was appointed by the Manufacturing Chemists Association to pass on the proposals of the informal committee and to recommend the adoption of the specifications resulting from the informal committee's work as standard for the members of the Manufacturing Chemists Association.

Arrangements have been made for full co-operation with the Committee on Guaranteed Reagents and Standard Apparatus of the American Chemical Society, and also with the Committee on Standards of the Association of Scientific Apparatus Makers of the United States of America. These specifications will be considered carefully by committees of these three societies, and it is expected that they will then be published as tentative for a period of six months in order to give time for general criticism. At the end of that time the specifications will be adopted as final.

In carrying on this work an effort will be made to obtain specifications which will insure the cheapest mode of manufacture of a given instrument consistent with the duties that it must perform.

To date, three meetings of this committee have been held and considerable progress has been made. The committee desires to co-operate fully with all industries, and any communications should be forwarded to the chairman, Dr. E. C. Lathrop, E. I. du Pont de Nemours & Co., Wilmington, Del.

Governmental Reorganization

While the matter of governmental reorganization is a subject of much comment on the part of lawmakers and others in Washington, it is very doubtful whether any consideration will be given to the subject on the floor of either house of Congress at the short session. Senator McCormick, of Illinois, has announced his intention of introducing a bill for the reorganization of the executive departments as a companion measure to his budget bill. This bill is along the same lines as that known as the Jones-Reavis bill. Senator McCormick's bill is not to supplant the Jones-Reavis measure, but it is apparent that no difficulties will be encountered in harmonizing the two measures in committee.

To Push Nitrogen Corporation Bill

Notice has been given in the Senate by Mr. Smith of South Carolina that he will insist upon prompt consideration of the bill providing for the establishment of a self-sustaining federal corporation for the production of atmospheric nitrogen. He expressed the hope that the bill would be acted upon before the holidays.

Forest Service Establishes New District in Alaska

The establishment of a new field district comprising the Chugach and Tongass National Forests in Alaska, with headquarters at Juneau, is announced by the Forest Service, to take effect Jan. 1, 1921. The new district will be in charge of District Forester Charles H. Flory, who is at present Superintendent of National Forests in Alaska. The establishment of the new district was decided upon in order to facilitate the transaction of the growing business of the two Alaskan national forests, and is in line with the policy of decentralized administration of the Forest Service. Nearly all of the business of the Alaskan forests will be transacted in the future on the ground by the district forester and the local forest officers, the officials of the Forest Service state.

The Tongass and Chugach national forests comprise 20,574,000 acres of land and include practically all of the best timber along the coast of Alaska. The sales of timber are increasing steadily and receipts from the two forests for the last fiscal year exceeded \$100,000. With the development of a paper industry, which is now in sight, officials of the Forest Service expect that the receipts will be greatly augmented. A sale for 100,000,000 ft. of pulp wood has already been made to a company which will establish a paper plant, and a sale of 1,500,000,000 ft. is in prospect.

The establishment of a paper-making industry, according to members of the Forest Service familiar with Alaskan conditions, will do much to stabilize the development of the territory. Alaska, it is said, is now in a condition somewhat like that of a worked-out mining camp. The rich placer mines have been exhausted, present prices of metal make it unprofitable to mine many of the lode claims, the salmon fisheries have been depleted, and there is no good market or means of transportation for such agricultural crops as are raised. Yet the undeveloped resources of the territory are very great. A paper industry will be perpetual because the timber on the national forests will be so cut as to insure regrowth, and the establishment of large manufacturing plants with the necessary towns for the workmen will afford steady employment for a considerable number of people, will increase transportation facilities and will create a market for crops produced locally.

The administration of the national forests has already been largely decentralized, the officials of the Forest Service state, but the establishment of a new district in charge of a district forester with large discretionary authority to transact Government business will further facilitate dispatch.

Personnel Changes in Bureau of Standards

During October there were thirty-one additions, twenty-two separations and fifty-nine promotions in the scientific staff of the Bureau of Standards, and during November sixteen additions, eight separations and twenty-eight promotions. Walter A. Hull has been transferred from the work on fire-resistive properties of materials to the Division of Ceramics and placed in charge of the work in connection with the production of optical glass. The resignations included none of the more advanced members of the staff. The additions to the staff included Paul R. Heyl, physicist, and W. L. Simpson and R. A. Webster, associate electrical engineers, and the reinstatement of A. Halsted, associate electrical engineer, William H. Smith and Alfred N. Finn, chemists.

Personal

L. S. CATES, assistant general manager of the Utah Copper Co., has returned to his headquarters at Salt Lake City after a trip to Boston, New York and Florida.

M. HAZEN CHASE has resigned his position as office manager and assistant to the superintendent of the Copescook mill of the S. D. Warren Co., Gardner, Maine, to accept one as assistant to R. R. Campbell, vice-president, in charge of manufacturing, of the American Writing Paper Co., Holyoke, Mass.

HIRAM W. CLARK, consulting engineer of the United States Bureau of Mines at Salt Lake City, has been appointed deputy smoke inspector of Salt Lake City.

J. L. HARMAN has been appointed manager of the El Paso branch of the Mine & Smelter Supply Co.

HERBERT C. HOOVER spoke before the Chicago Engineers' Club recently.

WILMER H. KOCH, formerly analytical chemist with E. I. du Pont de Nemours & Co. at its Lodi plant, is now in the research laboratory of the Mathieson Alkali Works, Niagara Falls, N. Y.

J. L. OLDRIGHT, formerly superintendent of the leaching division of the Chile Copper Co. at Chuquicamata, Chile, is visiting mining and metallurgical plants in the West.

WILLIAM RUSSELL, London representative of the Dorr Co., who has been in this country several months and who has been visiting Western metallurgical and Eastern industrial centers, sailed for England Dec. 15 on the Adriatic. He was tendered a dinner by thirty members of the Dorr staff on Dec. 14.

DANIEL H. SCHWARTZ, for the past twenty years superintendent at the Chemical Paper Co., Unit 5, Holyoke, Mass., has resigned his position with that company to accept one as general superintendent of the Ironside Board Corp., Norwich, Conn.

HENRY N. THOMPSON, formerly superintendent of the International smelter at Tooele, Utah, has been appointed instructor in metallurgy at the University of British Columbia at Vancouver.

ETHAN VIALI, for ten years on the staff of *American Machinist*, has resigned as editor to become a partner in the firm of T. W. Minton & Co., Barbourville, Ky.

Obituary

ELIJAH PADDOCK HARRIS, emeritus professor of chemistry at Amherst College, died on Dec. 10 at Warsaw, N. Y., after a long period of ill health. Prof. Harris was born in LeRoy, N. Y., April 3, 1832, and spent his boyhood on a farm with four months of school in the winter. He attended LeRoy Academy and the Seminary at Lima, N. Y., and spent the first two years of his college course at Genesee College. He graduated from Amherst in 1855, having entered as a junior, and immediately after graduation spent several years in teaching. In 1859 he received the degrees of A.M. and Ph.D. from the University of Göttingen. He became professor of chemistry and natural history at Victoria College, Coburg, remaining until 1866, when he went to Beloit College. He succeeded W. S. Clark as professor of chemistry at Amherst in 1868, and for forty years was instrumental in training many successful chemists. He retired in 1907 under the Carnegie Foundation at the age of seventy-five. Victoria College conferred upon him the degree of LL.D. in 1890. He was the author of several books on chemistry and was a member of Phi Beta Kappa and Psi Upsilon fraternities.

Current Market Reports

The Chemical and Allied Industrial Markets

New York, Dec. 20, 1920.

Inquiries for chemicals appear to be covering a somewhat larger field, and while it is admitted that there is considerable room for improvement, business is reported of a better volume than in the past few weeks.

Spot *bichromate of soda* was held at 9½c. lb. in most prominent quarters affiliated with resale stocks. Some dealers claim to be able to shade this price slightly and quotations were heard at 9¼@9¾c. per lb. for a few odd lots. December shipments were held at 9¼c. per lb. works, while January was quoted about 1c. above this price for delivery in New York. No change was heard in producers' views for future contracts and 15c. seemed to be the prevailing quotation. Resale solid *caustic soda* was held at \$3.75 per 100 lb. on spot in most resale quarters. Occasional sales were noted at \$3.65@3.70 per 100 lb. and outside makes were reported obtainable at 3½c. per lb. Demand for additional lots for shipment continued rather quiet. Producers' ideas were unaltered for future contracts and the market was quoted firm at 3¾c. per lb. basis 60 per cent works, for delivery over 1921.

Cyanide of soda was the most active chemical on the entire list during the past week. A noted increase in orders and inquiries was reported for the imported material. It was stated that several large orders were received from automobile manufacturers. Round lots were scarce and the market displayed a distinctly firmer tendency. Small quantities of the American grade were quoted at 28@30c. per lb., the outside figure being the producers' standard price. The German variety for shipment was quoted at 18½@20c. per lb., according to quantity and seller. Spot material was quoted at 24c. per lb. Producers are not inclined to shade 8c. per lb. on concentrated *sulphide of soda*, 60-62 per cent, in drums, for spot material. Dealers are in possession of moderate quantities of stock intended originally for export which they are offering at 7@7½c. per lb. Sales on *formaldehyde* were reported at 18½c. per lb. in bbl. by dealers and the general quotation was from 18½c. to 19c. per lb., depending on quantity. In some second-hand quarters it was stated that a few small lots might be purchased a shade under the inside figure, although it was admitted that the undertone of the general market was firm. Inquiries were said to be reaching the market from both domestic and export sources.

Odd lots of *oxalic acid* were on the market at 18c. per lb. Dealers stated that it was doubtful if much prime stock could be purchased below 18½c. per lb., while leading sellers were holding the market at 20c. per lb. The recent advance in this chemical has not met with the approval of buyers and trading continued along very quiet lines. Prime American *sulphate of aluminum*, iron free, was offered on the open market at 4c. per lb. f.o.b. New York. Imported material was available down to 3½c. per lb. and possibly a shade under this figure. The commercial grade was quoted at 2½@2¾c. per lb., with most sellers asking the outside price. Producers reported a well-sold-up condition, but there seems to be relatively little activity in the open market at present. Increased inquiries on *prussiate of soda* were noted during the week, and a fair amount of business was reported to have been placed on the basis of 17½c. per lb. Offerings were not heavy and the tone of the market appeared quite firm. At the close, 17½@18½c. per lb. was the prevailing quotation.

Light *soda ash* for future shipment is being booked by the consuming trade at \$1.82½@\$1.90 per 100 lb., basis 48 per cent, f.o.b. works, in single bags. Inquiries were said to be reaching the market in better volume than noted earlier in the month. According to the views of dealers, there is not much resale stock pressing at the present time. The market was quoted at \$1.90@\$1.95 per 100 lb. in bags, while barrels

were held as high as \$2.10 per 100 lb. At the works occasional lots brought \$1.70@ \$1.75 per 100 lb. in single bags.

COAL-TAR PRODUCTS

According to all advices, trading in coal-tar products was meager during the past week and prices in many cases were merely nominal. Consumers in all branches of the allied trades are holding off on account of uncertainty as to how far prices may be lowered. This is reflected in the coal-tar industry. Furthermore, if legislation on protective measures now before Congress is too long delayed, the market will reflect a serious uncertainty.

The crude market is in an easy position at present on supplies, and producers feel that there is a real demand and the time is not far off when it must be noticed. Intermediates in second hands still show irregular price levels with the tendency toward weakness. There is nothing radically new to report in the color market, except that considerable hard work is being put in on the dye protective measure and some interests feel very sanguine of favorable results. Supplies in second hands, while easy, are not being pushed to the extent they were a few weeks ago, and those that can afford to hold have determined not to take a conservative course in offering out supplies.

A rather stagnant condition is accorded to *cresol*, while makers report fair supplies ranging in prices from 16c. to 18c. per lb. Factors reported a moderate movement in *cresylic acid* against standing orders, but said there was very little new business coming through. Supplies were easy with continued shipments from abroad and prices ranged from 90c. to \$1 per gal. for the 95-97 per cent, and \$1@ \$1.05 per gal. for the 97-99 per cent. There have been no new developments of late that would signify any increase in the consuming demand for *metaphenylenediamine* and only small lots were said to be moving. Prices remained quothably unchanged at \$1.25@ \$1.30 per lb. Reports on *paratoluidine* from most quarters showed very little new business and only small lots moving against standing orders. Supplies were available in fair volume at \$1.75@ \$1.85 per lb. Buyers are only taking very limited quantities of *paranitraniline* at this period. Supplies were plentiful in most quarters and prices ranged from 92c. to \$1 per lb., according to quantity and seller. *Beta naphthol* prices have halted in their downward course and seemed to be more uniform around 40@43c. per lb. *Phenol* has strengthened somewhat, with prices around 10@12c. per lb., none of the low quotations recently heard being in evidence.

Denatured Alcohol Production

All distilleries and industrial distilleries producing alcohol were required to requalify as industrial alcohol plants when the national prohibition act became effective, according to a recent report of the Commissioner of Internal Revenue for 1920. On June 30, 1920, there were thirty-seven industrial alcohol plants, compared with forty-seven distilleries operating prior to October, 1919.

At the close of the fiscal year 1919 there were forty-seven distilleries operating. There were in operation June 30, 1920, twenty-four denaturing plants, compared with forty-five denaturing warehouses and one redenaturing plant operated at the close of the fiscal year 1919. The number of bonded manufacturers using specially denatured alcohol increased during the fiscal year 1919, indicating an increased use of industrial alcohol.

During the fiscal year ended June 30, 1920, there was produced from materials other than fruit 99,615,792 taxable gallons of distilled spirits, an increase of 639,673 gallons compared with the quantity produced during the preceding fiscal year. Of this class of spirits there was removed from bonded warehouses on payment of tax 28,220,909 taxable gallons, a decrease of 53,377,176 from the quantity taxed during the preceding fiscal year, due to the prohibition laws which prevented the use of such spirits for beverage purposes. Herewith are shown the quantities of distilled spirits produced, withdrawn and remaining in bond during the fiscal years 1910, 1915 and 1920.

In 1910: Produced, 156,237,526.4 gal; withdrawn, 126,384,726.7; in warehouse, 233,508,674.6.

In 1915: Produced, 132,134,152.2; withdrawn, 121,498,325; in warehouse, 253,668,341.3.

In 1920: Produced, 99,615,792; withdrawn, 28,220,909.6; in warehouse, 55,863,745.2.

During the fiscal year 1920 there was withdrawn from bond, free of tax, for denaturation, 45,640,948 gal. of alcohol and rum, as against 60,399,308 withdrawn for the same purpose the previous year. The growth of the denaturing industry in this country during the past 14 years is shown by the following data beginning with 1907:

In 1907: Eight denaturing warehouses, producing 397,861.16 wine gallons of completely denatured alcohol and 382,415.19 wine gallons of specially denatured, a total of 3,084,950.8 proof gallons.

In 1910: Twelve denaturing warehouses, producing 3,076,924.55 wine gallons of completely denatured alcohol and 3,002,102.55 wine gallons of specially denatured, a total of 10,605,870.7 proof gallons.

In 1915: Twenty-three denaturing warehouses, producing 5,386,646.96 wine gallons of completely denatured alcohol and 3,002,102.55 wine gallons of specially denatured, a total of 25,411,718.1 proof gallons.

In 1920: Fifty-two denaturing warehouses producing 13,528,402.99 wine gallons of completely denatured alcohol and 15,307,947.18 wine gallons of specially denatured, a total of 45,640,948.6 proof gallons.

While the 1920 total is much larger than for 1915, there was a reduction from last year's total of about 15,000,000 proof gallons. Total proof gallons for 1919 were 60,399,308.9.

The Iron and Steel Market

Pittsburgh, Dec. 17, 1920.

Changes in market prices in the iron and steel industry in the past week have been few and unimportant. Tin plate, bars, shapes, plates, wire products and sheets, in all of which the independent market recently dropped to the Steel Corporation level, have undergone no further change. Shading by some of the independents is expected, but this has not been observed as yet, partly no doubt because the situation is so new and partly also without doubt because there has been little if any business offered that would induce price competition. Already some members of the trade have picked out some producers as being most likely to shade prices eventually and others who are at least likely to do so.

Pipe, in which the independent market did not decline to the Steel Corporation or Industrial Board level when so many other products did, is unchanged in the independent market, but in the past week there have suddenly appeared a great many postponements of deliveries against contracts, with a few cancellations, and the independents will probably soon have occasion to replace their 54 per cent list with the 57½ per cent list the Steel Corporation has maintained. The difference is about \$7 per net ton. Delivery premiums that were formerly obtained by independents have disappeared recently.

OPERATIONS

The altogether unprecedented performance of the Steel Corporation maintaining a certain set of prices and all the independents obtaining for a long time not only higher prices but in many cases very much higher prices would naturally have an aftermath, and that is now being experienced. The United States Steel Corporation has increased its rate of production, while the production rate of the independents is rapidly decreasing. The Steel Corporation's increase is not on account of its having more orders or being under greater pressure for deliveries, but because better transportation conditions have increased its supplies of coal and coke. A number of blast furnaces, long idle perforce, have lately been blown in. The corporation's rate of ingot production is now about 91 per cent of capacity, against 88 per cent two or three weeks ago. Some independents are down entirely, while others are operating at 50 to 75 per cent. The average independent rate is probably under 40 per cent and it is a common view that by the end of the year many independents will be closed entirely.

The Steel Corporation's steel ingot capacity, as indicated

by the last annual report, is about 23,000,000 tons per annum. The total capacity of the country may be taken at about 52,500,000 tons, which would set the independents at 29,500,000 tons. At 91 per cent the Steel Corporation would be making ingots at the rate of 21,000,000 tons per annum. The average production rate during the first ten months of this year was 42,000,000 tons, with only minor variations from the average for a month or two at a time. Consumption did not exceed the production rate, as there were no stocks Jan. 1, and there may have been some stocks Nov. 1. Thus the steel required from independents is only the amount by which consumption exceeds one-half the consumption during the period in which consumption was regarded as very heavy and steel was very scarce. If consumption is reduced by one-third, there is left a rate of 7,000,000 tons a year for the independents, or 24 per cent of capacity. This seems remarkable, but it appears less so when it is considered, first, that on account of various difficulties the steel industry operated at only about 80 per cent of capacity in the first ten months of this year and second, that after the very remarkable price performances of the past twelve months the relative positions of the Steel Corporation and independents could not possibly become normal in any short space of time.

SEMI-FINISHED STEEL

A large independent interest which has been particularly rigid in efforts to maintain prices has revised its sheet bar contracts to \$47, which is commonly recognized as the Steel Corporation price. Other mills are understood to be willing to sell sheet bars at this price, but there is no demand. Some sheet mills insist that the Steel Corporation's advance from \$42 to \$47 last September must be regarded as merely temporary and they are therefore indisposed to buy at above \$42, particularly since that is the Industrial Board price and the sheet market is now at Industrial Board prices. Billets are altogether indeterminate, there being no demand. Some slabs have been sold by plate mills at special prices.

PIG IRON AND COKE

Resale foundry iron has been offered so freely at \$35 valley basis or less and has met with so little sale that the market is easily quotable at not over \$35, the last regular furnace quotation having been \$37. Bessemer remains quotable at \$35 valley, and basic at \$33. Prices are practically nominal. The appearance of important inquiry would doubtless bring out competitive and therefore lower prices, but the demand does not appear. Part of the decline to date from the top prices reached last August has been more or less by way of voluntary action on the part of furnaces, but there is no disposition to go farther in that spirit. The lowest prices for pig iron on this decline will probably be developed after a regular buying movement has begun, whenever that may be, not when, as at present, furnaces are facing the prospect of going out of blast but rather when idle furnaces are thinking of getting into blast and are therefore desirous of selling some "backlog" tonnage for a start.

The average furnaceman is indisposed to consider the making of coke contracts for the first half of the new year, even though these contracts are by trade custom "requirement" contracts, so that the furnaceman is under no obligation if his stack is out. Furnacemen think developments of the near future will reduce Connellsville coke operators to lower terms than they are disposed to consider at present, while as a rule they see no definite prospect of having occasion to operate. This week an exception is to be recorded, however, as one coke interest has closed contracts with merchant furnaces involving coke equal to about 80 per cent of its capacity, or sufficient for four or five medium sized stacks. These contracts were all written on the general basis of a 5 to 1 ratio against basic pig iron, valley, the invoice price of the coke each month per net ton at ovens to be one-fifth the quoted market price of valley basic iron. That would be \$6.60 if pig iron stayed at its present level. The contracts contain a minimum for coke, also a change to a stiffer ratio in case pig iron should reach a certain level above the present price.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride.....	lb.	\$0.13 - \$0.13	\$0.55 - \$0.60
Acetone.....	lb.	3.00 - 3.25	13 - 14
Acid, acetic, 28 per cent.....	100 lbs.	7.25 - 7.50	3.50 - 3.75
Acetic, 56 per cent.....	100 lbs.		7.75 - 8.00
Acetic, glacial, 99 1/2 per cent, carboys.....	100 lbs.	10.50 - 11.00	11.25 - 11.50
Boric, crystals.....	lb.	14 - 15	15 - 16
Boric, powder.....	lb.	15 - 16	17 - 18
Citric.....	lb.		52 - 54
Hydrochloric (nominal).....	100 lb.	1.85 - 2.25	2.75 - 3.00
Hydrofluoric, 52 per cent (nominal).....	lb.	15 - 16	16 - 18
Lactic, 44 per cent tech.....	lb.	10 - 11	11 - 12
Lactic, 22 per cent tech.....	lb.	04 - 05	06 - 07
Molybdic, C. P.....	lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric).....	lb.	07 - 07	08 - 08
Nitric, 40 deg.....	lb.	07 - 08	08 - 09
Nitric, 42 deg.....	lb.	18 - 18	18 - 20
Oxalic, crystals.....	lb.	18 - 18	18 - 19
Phosphoric, Ortho, 50 per cent solution.....	lb.	28 - 35	40 - 50
Picric.....	lb.	2.30 - 2.55	2.60 - 2.65
Pyrogallol, resublimed.....	lb.		14.00 - 15.00
Sulphuric, 60 deg., tank cars.....	ton	18.00 - 19.00	22.50 - 23.00
Sulphuric, 60 deg., drums.....	ton	21.00 - 22.00	
Sulphuric, 66 deg., tank cars.....	ton		
Sulphuric, 66 deg., drums.....	ton		
Sulphuric, 66 deg., carboys.....	ton		
Sulphuric, fuming, 20 per cent (oleum).....	ton	23.00 - 24.00	
Sulphuric, fuming, 20 per cent (oleum).....	drums.....	25.00 - 26.00	26.50 - 27.00
Sulphuric, fuming, 20 per cent (oleum).....	carboys.....	32.00 - 35.00	40.00 -
Tannic, U. S. P.....	lb.	50 - 55	1.30 - 1.35
Tannic (tech.).....	lb.		56 - 60
Tartaric, crystals.....	lb.		42 - 44
Tungstic, per lb. of WO.....	lb.		1.20 - 1.40
Alcohol, Ethyl (nominal).....	gal.		5.50 - 6.00
Alcohol, Methyl (see methanol).....			82 - 84
Alcohol, denat. red, 188 proof (nominal).....	gal.		88 - 90
Alcohol, denatured, 190 proof (nominal).....	gal.		05 - 05
Alum, ammonia lump.....	lb.	04 - 04	06 - 07
Alum, potash lump.....	lb.	05 - 06	14 - 14
Alum, chrome lump.....	lb.	13 - 13	03 - 03
Aluminum sulphate, commercial.....	lb.	02 - 03	04 - 04
Aluminum sulphate, iron free.....	lb.	03 - 03	08 - 08
Aqua ammonia, 26 deg., drums (750 lb.).....	lb.	07 - 08	36 - 38
Ammonia, anhydrous, cyl. (100-150 lb.).....	lb.	33 - 35	14 - 15
Ammonium carbonate, powder.....	lb.	14 - 14	11 - 11
Ammonium chloride, granular (white salamoniac) (nominal).....	lb.	10 - 11	10 - 11
Ammonium chloride, granular (gray salamoniac).....	lb.	13 - 10	11 - 14
Ammonium nitrate.....	lb.	03 - 04	04 - 04
Ammonium sulphate.....	lb.		4.50 - 5.00
Amylacetate.....	gal.		4.00 - 4.20
Amylacetate tech.....	gal.		11 - 12
Arsenic oxide, lumps (white arsenic).....	lb.	11 - 12	15 - 15
Arsenic, sulphide, powdered (red arsenic).....	lb.	15 - 15	75.00 - 80.00
Barium chloride.....	ton	24 - 25	26 - 27
Barium dioxide (peroxide).....	lb.	12 - 12	13 - 13
Barium nitrate.....	lb.	04 - 05	05 - 06
Barium sulphate (precip.) (blanc fixe).....	lb.		
Bleaching powder (see calc. hypochlorite).....			
Blue vitriol (see copper sulphate).....			
Borax (see sodium borate).....			
Brimstone (see sulphur, roll).....			
Bromine.....	lb.	50 - 52	54 - 56
Calcium acetate.....	100 lbs.	2.00 - 2.25	
Calcium carbide.....	lb.	04 - 04	04 - 05
Calcium chloride, fused, lump.....	ton	30.00 - 32.00	33.00 - 35.00
Calcium chloride, granulated.....	lb.	03 - 02	03 - 03
Calcium hypochlorite (bleach'g powder).....	lb.	03 - 03	1.50 - 1.70
Calcium peroxide.....	lb.		75 - 80
Calcium phosphate, monobasic.....	lb.		25 - 30
Calcium sulphate, pure.....	lb.		90 - 95
Camphor.....	lb.		08 - 09
Carbon bisulphide.....	lb.	12 - 12	12 - 13
Carbon tetrachloride, drums.....	lb.		60 - 75
Carbonyl chloride (phosgene).....	lb.		
Caustic potash (see potassium hydroxide).....			
Caustic soda (see sodium hydroxide).....			
Chlorine, gas, liquid-cylinders (100 lb.).....	lb.	09 - 09	10 - 10
Chloroform.....	lb.		43 - 50
Cobalt oxide.....	lb.		3.90 - 4.00
Copperas (see iron sulphate).....			
Copper carbonate, green precipitate.....	lb.	22 - 22	24 - 25
Copper cyanide.....	lb.		65 - 70
Copper sulphate, crystals.....	lb.	06 - 06	07 - 07
Cream of tartar (see potassium bitartrate).....			
Epsom salt (see magnesium sulphate).....			
Ethyl Acetate Com. 85%.....	gal.		1.05 - 1.10
Ethyl Acetate pure (acetic ether 98% to 100%).....			
Formaldehyde, 40 per cent (nominal).....	lb.	18 - 18	19 - 19
Fusel oil, ref.....	gal.		3.60 - 3.75
Fusel oil, crude (nominal).....	gal.		3.00 - 3.25
Glauber's salt (see sodium sulphate).....			
Glycerine, C. P. drums extra.....	lb.		20 - 21
Iodine, resublimed.....	lb.		3.85 - 4.00
Iron oxide, red.....	lb.		15 - 25
Iron sulphate (copperas).....	100 lb.	1.50 - 1.75	2.00 - 2.25
Lead acetate, normal.....	lb.		13 - 16
Lead arsenate (paste).....	lb.	13 - 14	14 - 15
Lead nitrate, crystals.....	lb.		90 - 1.00
Litharge.....	lb.	12 - 12	13 - 13
Lithium carbonate.....	lb.		1.50 -
Magnesium carbonate, technical.....	lb.	10 - 11	11 - 12
Magnesium sulphate, U. S. P.....	100 lb.	3.00 - 3.25	
Magnesium sulphate, commercial.....	100 lb.		1.50 - 1.75
Methanol, 95%.....	gal.		1.75 - 1.80
Methanol, pure.....	gal.		2.20 - 2.35
Nickel salt, double.....	lb.		12 - 12
Nickel salt, single.....	lb.		13 - 13
Phosgene (see carbonyl chloride).....			
Phosphorus, red.....	lb.	50 - 52	53 - 55
Phosphorus, yellow.....	lb.		35 - 37
Potassium bichromate.....	lb.	17 - 17	18 - 18

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb.	\$0.45 - \$0.47	\$0.38 - \$0.40
Potassium bromide, granular	lb.	—	43 - 50
Potassium carbonate, U. S. P.	lb.	50 - 55	56 - 60
Potassium carbonate, crude	lb.	13 - 13½	13½ - 14
Potassium chlorate, crystals	lb.	12 - 13	13½ - 18
Potassium hydroxide (caustic potash)	lb.	14 - 14½	15 - 16
Potassium iodide	lb.	—	3.00 - 3.20
Potassium nitrate	lb.	14 - 16	16½ - 17
Potassium permanganate	lb.	60 - 63	65 - 70
Potassium prussiate, red	lb.	55 - 57	58 - 60
Potassium prussiate, yellow	lb.	33 - 33½	33 - 34
Potassium sulphate (powdered)	ton	\$240.00 - 255.00	—
Rochelle salts (see sodium potas. tartrate)	—	—	—
Salammoniac (see ammonium chloride)	—	—	—
Salsoda (see sodium carbonate)	—	—	—
Salt cake	ton	—	45.00 - 50.00
Silver cyanide (nominal)	oz.	—	1.25 - 42
Silver nitrate (nominal)	oz.	—	41 - 42
Soda ash, light	100 lb.	1.90 - 2.00	2.10 - 2.30
Soda ash, dense	100 lb.	2.30 - 2.50	2.75 - 3.00
Sodium acetate	lb.	0.61 - 0.7	0.7 - 0.7½
Sodium bicarbonate	100 lb.	2.45 - 2.60	2.65 - 3.00
Sodium bichromate	lb.	0.9 - 0.9½	0.9½ - 1.0
Sodium bisulphate (nitre cake)	ton	7.00 - 7.50	8.00 - 11.00
Sodium bisulphate powdered, U. S. P.	lb.	0.61 - 0.7	0.7 - 0.8
Sodium borate (borax)	lb.	0.81 - 0.8½	0.9 - 0.9½
Sodium carbonate (salsoda)	100 lb.	2.00 - 2.25	2.50 - 2.75
Sodium chloride	lb.	10 - 10½	10½ - 11
Sodium cyanide, 96-98 per cent.	lb.	23 - 25	26 - 30
Sodium fluoride	lb.	17 - 17½	17½ - 18½
Sodium hydroxide (caustic soda)	100 lb.	3.75 - 4.00	4.25 - 4.35
Sodium hyposulphite	lb.	—	0.4 - 0.4½
Sodium molybdate	lb.	2.50 - 2.55	3.25 - 3.50
Sodium nitrate	100 lb.	2.85 - 3.00	3.00 - 3.25
Sodium nitrite	lb.	0.61 - 0.6½	0.7 - 0.7½
Sodium peroxide, powdered	lb.	30 - 31	32 - 34
Sodium phosphate, dibasic	lb.	0.31 - 0.4	0.4 - 0.5
Sodium potassium tartrate (Rochelle salts)	lb.	—	33 - 35
Sodium prussiate, yellow	lb.	17½ - 17	18 - 18½
Sodium silicate, solution (40 deg.)	lb.	0.11 - 0.12	0.2 - 0.2½
Sodium silicate, solution (60 deg.)	lb.	0.3 - 0.3½	0.3½ - 0.4
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	2.15 - 2.50	2.60 - 2.75	—
Sodium sulphide, crystal, 60-62 per cent (conc.) lb.	0.7 - 0.7½	0.7½ - 0.8	—
Sodium sulphite, crystals	lb.	0.4 - 0.4½	0.4½ - 0.5
Strontium nitrate, powdered	lb.	20 - 20½	21 - 22
Sulphur chloride, red	lb.	0.8 - 0.9	1.0 - 1.0½
Sulphur, crude	ton	16.00 - 20.00	—
Sulphur dioxide, liquid, cylinders	lb.	—	10 - 12
Sulphur (sublimed), flour	100 lb.	—	3.70 - 4.35
Sulphur, roll (brimstone)	100 lb.	—	3.40 - 3.90
Tin bichloride, 50 per cent.	lb.	18 - 19	—
Tin oxide	—	—	50 - 51
Zinc carbonate, precipitate	lb.	16 - 18	19 - 20
Zinc chloride, gran.	lb.	12 - 13	13½ - 14
Zinc cyanide	lb.	45 - 49	50 - 60
Zinc dust	lb.	12 - 13	13 - 14
Zinc oxide, XX	lb.	10 - 10½	11 - 11½
Zinc sulphate	lb.	0.31 - 0.3½	0.4 - 0.6

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	\$1.10 - \$1.15
Alpha-naphthol, refined	lb.	1.45 - 1.50
Alpha-naphthylamine	lb.	44 - 46
Aniline oil, drums extra	lb.	26 - 27
Aniline salts	lb.	32 - 33
Anthracene, 80% in drums (100 lb.)	lb.	90 - 1.00
Benzaldehyde (f.f.c.)	lb.	2.00 - 2.10
Benidine, base	lb.	1.00 - 1.10
Benidine sulphate	lb.	85 - 90
Benzoic acid, U. S. P.	lb.	75 - 80
Benzoate of soda, U. S. P.	lb.	75 - 85
Benzene, pure, water-white, in drums (100 gal.)	gal.	33 - 36
Benzene, 90% in drums (100 gal.)	gal.	32 - 35
Benzyl chloride, 95-97%, refined	lb.	35 - 40
Benzyl chloride, tech.	lb.	25 - 35
Beta-naphthol benzoate (nominal)	lb.	3.50 - 4.00
Beta-naphthol, sublimed (nominal)	lb.	75 - 80
Beta-naphthol, tech (nominal)	lb.	40 - 45
Beta-naphthylamine, sublimed	lb.	2.25 - 2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	16 - 18
Ortho-cresol, in drums (100 lb.)	lb.	23 - 25
Cresylic acid, 97-99%, straw color, in drums	gal.	1.00 - 1.05
Cresylic acid, 95-97%, dark, in drums	gal.	90 - 1.00
Cresylic acid, 50%, first quality, drums	gal.	65 - 75
Dichlorobenzene	lb.	0.7 - 1.0
Diethylaniline	lb.	1.45 - 1.50
Dimethylaniline	lb.	65 - 90
Dinitrobenzene	lb.	30 - 37
Dinitrochlorobenzene	lb.	27 - 32
Dinitronaphthalene	lb.	42 - 45
Dinitrophenol	lb.	40 - 45
Dinitrotoluene	lb.	30 - 32
Dip oil, 25% tar acids, car lots, in drums	gal.	38 - 40
Diphenylamine (nominal)	lb.	75 - 77
H-acid (nominal)	lb.	1.45 - 1.60
Meta-phenylenediamine	lb.	1.25 - 1.30
Monochlorobenzene	lb.	17 - 18
Monothylaniline	lb.	1.75 - 2.25
Naphthalene crushed, in bbls. (250 lb.)	lb.	0.9 - 0.9½
Naphthalene, flake	lb.	0.9 - 0.9½
Naphthalene, balls	lb.	0.9 - 1.0
Naphthionic acid, crude	lb.	70 - 75
Nitrobenzene	lb.	12 - 15
Nitro-naphthalene	lb.	40 - 50
Nitro-toluene	lb.	18 - 25
Ortho-amidophenol	lb.	3.20 - 3.75
Ortho-dichlorobenzene	lb.	15 - 20
Ortho-nitro-phenol	lb.	75 - 80
Ortho-nitro-toluene	lb.	25 - 40
Ortho-toluidine	lb.	30 - 32
Para-amidophenol, base	lb.	2.10 - 2.20
Para-amidophenol, HCl	lb.	2.25 - 2.40
Para-dichlorobenzene	lb.	10 - 15
Paranitroaniline	lb.	.93 - 1.00

Para-nitrotoluene	lb.	1.25 - 1.40
Para-phenylenediamine	lb.	2.20 - 2.35
Para-toluidine	lb.	1.75 - 1.85
Phthalic anhydride	lb.	.60 - .70
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.10 - .12
Pyridine	gal.	2.00 - 3.50
Resorcinol, technical	lb.	2.90 - 3.00
Resorcinol, pure	lb.	3.75 - 4.15
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.35 - .38
Salicylic acid, U. S. P.	lb.	.40 - .45
Salol	lb.	.85 - .95
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.30 - .35
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.19 - .22
Sulphanilic acid, crude	lb.	.32 - .35
Tolidine	lb.	1.40 - 1.45
Toluidine, mixed	lb.	.45 - .55
Toluene, in tank cars	gal.	.30 - .32
Toluene, in drums	gal.	.33 - .35
Xylidines, drums, 100 gal.	lb.	.45 - .50
Xylene, pure, in drums	gal.	.45 - .47
Xylene, pure, in tank cars	gal.	.45 - .47
Xylene, commercial, in drums, 100 gal.	gal.	.37 - .38
Xylene, commercial, in tank cars	gal.	.30 - .32

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	\$0.26 - \$0.27
Beeswax, refined, light	lb.	.28 - .30
Beeswax, white pure	lb.	.35 - .40
Carnauba, No. 1 (nominal)	lb.	.80 - .90
Carnauba, No. 2, North Country	lb.	.70 - .80
Carnauba, No. 3, North Country	lb.	.25 - .26
Japan	lb.	.19 - .20
Montan, crude	lb.	.12 - .14
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.07 - .08
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.07 - .07½
Paraffine waxes, refined, 118-120 m.p.	lb.	.09 - .09½
Paraffine waxes, refined, 125 m.p.	lb.	.09 - .09½
Paraffine waxes, refined, 128-130 m.p.	lb.	.10 - .11
Paraffine waxes, refined, 133-135 m.p.	lb.	.13 - .14
Paraffine waxes, refined, 135-137 m.p.	lb.	.14 - .15
Stearic acid, single pressed	lb.	.17 - .17½
Stearic acid, double pressed	lb.	.18 - .19
Stearic acid, triple pressed	lb.	.22 - .23

Flotation Oils

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp.gr. 0.930-0.940	gal.	\$1.90
Pine oil, pure, dist. dist.	gal.	1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.75
Pine tar, ref., thin, sp.gr. 1.080-1.960	gal.	.36
Turpentine, crude, sp.gr. 0.900-0.970	gal.	1.25
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990	gal.	.35
Pine wood creosote, ref.	gal.	.52

Naval Stores

The following prices are f.o.b. New York for carload lots.

Rosin B-D, bbl.	280 lb.	\$8.50 -
Rosin E-I	280 lb.	8.50 -
Rosin K-N	280 lb.	8.50 -
Rosin W. G.-W. W.	280 lb.	8.75 -
Wood rosin, bbl.	280 lb.	9.00 -
Spirits of turpentine	gal.	.77 -
Wood turpentine, steam dist.	gal.	.75 -
Wood turpentine, red, dist.	gal.	.75 -
Pine tar pitch, bbl.	200 lb.	8.50 -
Tar, kiln burned, bbl. (500 lb.)	bbl.	15.00 -
Retort tar, bbl.	500 lb.	15.00 - 15.50
Rosin oil, first run	gal.	.60 -
Rosin oil, second run	gal.	.62 -
Rosin oil, third run	gal.	.75 -

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	\$0.41
70-72 deg., steel bbls. (85 lb.)	gal.	.39
68-70 deg., steel bbls. (85 lb.)	gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.30

Crude Rubber

Para-Upriver fine (nominal)	lb.	\$0.21 - \$0.21½
Upriver coarse (nominal)	lb.	.14 - .15
Upriver cauchothall (nominal)	lb.	.15 - .15½
Plantation—First latex crepe	lb.	.17 -
Ribbed smoked sheets	lb.	.16 -
Brown crepe, thin, clean	lb.	.16 -
Amber crepe No. 1	lb.	.17 -

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	\$0.13 - \$0.14
Castor oil, AA, in bbls.	lb.	.14 - .15
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.09 - .10
Cocanut oil, Ceylon grade, in bbls.	lb.	.13 - .13½
Cocanut oil, Cochinchina grade, in bbls. (nominal)	lb.	.13 - .14
Cori oil, crude, in bbls.	lb.	.09 - .10
Cottonseed oil, crude (f. o. b. mill)	lb.	.06 - .07
Cottonseed oil, summer yellow	lb.	.09 - .09½
Cottonseed oil, winter yellow	lb.	.10 - .11
Linseed oil, raw, car lots (domestic)	gal.	.81 - .82
Linseed oil, raw, tank cars (domestic)	gal.	.75 - .77
Linseed oil, boiled, car lots (domestic)	gal.	.83 - .84

Olive oil, commercial.....	gal.	2.75	—	3.00
Palm, Lagos.....	lb.	.08	—	.09
Palm, Niger.....	lb.	.07	—	.08
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.08	—	.09
Peanut oil, refined, in bbls.....	lb.	.14	—	.14
Rapeseed oil, refined in bbls.....	gal.	1.15	—	1.20
Rapeseed oil, blown, in bbls.....	gal.	1.25	—	1.35
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.09	—	.10
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.06	—	.07

FISH

Light pressed Menhaden.....	gal.	\$0.65	—	\$0.70
Yellow bleached Menhaden.....	gal.	.67	—	.70
White bleached Menhaden.....	gal.	.72	—	.75
Blown Menhaden.....	gal.	1.05	—	1.10

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	\$30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	25.00
Barytes, crude, 88% to 94% ba., Kings Creek.....	net ton	19.00	—	17.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	10.00	—	10.00
Blanc fixe, dry.....	lb.	.05	—	.05
Blanc fixe, pulp.....	net ton	60.00	—	65.00
Caseine.....	lb.	.14	—	.18
Chalk, domestic, extra light.....	lb.	.05	—	.06
Chalk, domestic, light.....	lb.	.05	—	.05
Chalk, domestic, heavy.....	lb.	.04	—	.05
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.05	—	.06
Chalk, English, dense.....	lb.	.04	—	.05
China clay, (Kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	—	10.00
China clay (Kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (Kaolin) ground, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (Kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (Kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	—	40.00
China clay (Kaolin), imported, lump.....	net ton	25.00	—	35.00
China clay (Kaolin), imported, powdered.....	net ton	30.00	—	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground f.o.b. Palmito.....	net ton	27.00	—	30.00
Fuller's Earth, f.o.b. New York.....	net ton	16.00	—	17.00
Fuller's earth, granular, f.o.b. Fla.....	net ton	25.00	—	25.00
Fuller's earth, powdered, f.o.b. Fla.....	net ton	18.00	—	18.00
Fuller's earth, imported, powdered.....	net ton	35.00	—	40.00
Graphite, crucible, 90% carbon, Ashland, Ala.....	lb.	.07	—	.09
Graphite, crucible, 85% carbon, Ashland, Ala.....	lb.	.11	—	.40
Graphite, higher lubricating grades.....	lb.	.04	—	.50
Pumice stone, imported, lump.....	lb.	.06	—	.06
Pumice stone, domestic, lump.....	lb.	.04	—	.07
Pumice stone, ground.....	lb.	.04	—	.07
Quartz (acid tower) fist to head, f.o.b. Baltimore.....	net ton	10.00	—	10.00
Quartz (acid tower) 1 1/2 to 2 in., f.o.b. Baltimore.....	net ton	14.00	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	17.00	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	1.00	—	1.05
Shellac, orange superfine.....	lb.	1.05	—	1.10
Shellac, A. C. garnet.....	lb.	.90	—	.95
Shellac, T. N.....	lb.	.85	—	.95
Sonapstone.....	ton	15.00	—	25.00
Sodium Chloride.....	long ton	—	—	17.50
Talc, paper-making grades, f.o.b. Vermont.....	ton	12.00	—	22.00
Talc, roofing grades, f.o.b. Vermont.....	ton	9.50	—	15.00
Talc, rubber grades, f.o.b. Vermont.....	ton	12.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	12.00	—	15.00
Talc, imported.....	ton	60.00	—	70.00
Talc, California Talcum Powder grade.....	ton	20.00	—	45.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	1,000	160	—	160
Chrome brick, f.o.b. Eastern shipping points.....	net ton	100-110	—	100-110
Chrome cement, 40-45% Cr ₂ O ₃	net ton	55-60	—	55-60
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	60-65	—	60-65
Fire clay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	55-60	—	55-60
Fire clay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	45-50	—	45-50
Magnesite brick, 9-in. straight.....	net ton	110	—	110
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	121	—	121
Magnesite brick, soaps and splits.....	net ton	134	—	134
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	65-70	—	65-70
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	56-61	—	56-61
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	55-60	—	55-60

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, car lots.....	lb.	.16	—	.17
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, car lots.....	lb.	.17	—	.18
Ferro-manganese, 76-80% Mn, domestic.....	gross ton	140.00	—	145.00
Ferro-manganese, 76-80% Mn, English.....	gross ton	135.00	—	140.00
Spiegelisen, 18-22% Mn.....	lb.	60.00	—	65.00
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.....	gross ton	2.00	—	2.50
Ferro-silicon, 10-15%.....	gross ton	60.00	—	65.00
Ferro-silicon, 50%.....	gross ton	78.00	—	80.00
Ferro-silicon, 75%.....	gross ton	—	—	160.00
Ferro-tungsten, 70-80%, per lb. of contained W.....	lb.	.65	—	.75
Ferro-uranium, 35-50% of U, per lb. of U content.....	lb.	7.00	—	7.50
Ferro-vanadium, 30-40% per lb. of contained V.....	lb.	6.50	—	7.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al. content, less than 2% Fe ₂ O ₃ , up to 20% silica, not more than 14% moisture.....	gross ton	\$10.00	—	\$11.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	.60	—	.65
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic Seaboard.....	unit	.60	—	.65
Coke, foundry, f.o.b. ovens.....	net ton	8.50	—	9.00
Coke, furnace, f.o.b. ovens.....	net ton	7.00	—	7.50
Coke, petroleum, refinery, Atlantic Seaboard.....	net ton	24.00	—	26.00
Fluor spar, lump, f.o.b. Tonuco, New Mexico.....	net ton	17.50	—	17.50
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	22.50	—	25.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01	—	.01
Manganese Ore, 50% Mn, r.f.f. Atlantic seaport.....	unit	.45	—	.50
Manganese ore, chemical (MnO ₂).....	gross ton	60.00	—	65.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55	—	.60
Monazite, per unit of ThO ₂ , c.f.f. Atlantic seaport.....	unit	35.00	—	35.00
Pyrites, Spanish, fines, c.f.f., Atlantic seaport.....	unit	.12	—	.12
Pyrites, Spanish, furnace size, c.f.f., Atlantic seaport.....	unit	.17	—	.17
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12	—	.14
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	.15
Tungsten, Scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	4.25	—	4.50
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	4.00	—	4.25
Uranium ore (Carnotite) per lb. of U ₃ O ₈	lb.	2.75	—	3.00
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.75	—	3.00
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium Ore, per lb. of V ₂ O ₅ contained.....	lb.	1.50	—	1.50
Zircon, washed, iron free.....	lb.	.05	—	.05

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	15.00
Aluminum, 98 to 99 per cent.....	22.00 @ 33.00
Antimony, wholesale lots, Chinese and Japanese.....	5.62
Nickel, ordinary (ingot).....	43.00
Nickel, electrolytic.....	45.00
Tin, 5-ton lots.....	35.25
Lead, New York, spot.....	5.7
Lead, E. St. Louis, spot.....	6.25
Zinc, spot, New York.....	7.00
Zinc, spot, E. St. Louis.....	6.75

OTHER METALS

Silver (commercial).....	oz.	—	—	—
Cadmium.....	lb.	\$1.40 @ 1.50	—	—
Bismuth (500 lb. lots).....	lb.	2.40	—	—
Cobalt.....	lb.	6.00	—	—
Magnesium (f.o.b. Niagara Falls).....	lb.	1.75	—	—
Platinum.....	oz.	85.00	—	—
Iridium.....	oz.	350.00 @ 400.00	—	—
Palladium.....	oz.	85.00	—	—
Mercury.....	.75 lb.	48.00 @ 49.00	—	—

FINISHED METAL PRODUCTS

Warehouse Prices Cents per Lb.

Copper sheets, hot rolled.....	22.50
Copper bottoms.....	34.00
Copper rods.....	29.00
High brass wire and sheets.....	22.25
High brass rods.....	18.25
Low brass wire and sheets.....	30.5
Low brass rods.....	19.50
Brazed brass tubing.....	36.25
Brazed bronze tubing.....	41.50
Seamless copper tubing.....	26.00
Seamless high brass tubing.....	25.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York				Cleveland				Chicago			
	Current	One Month Ago	One Year Ago	Current	One Month Ago	One Year Ago	Current	One Month Ago	One Year Ago	Current	One Month Ago	One Year Ago
Copper, heavy and crucible.....	12.00	17.00	10.00	11.50	16.00	9.50	11.00	15.00	8.50	10.50	14.00	7.50
Copper, heavy and wire.....	11.50	16.00	9.50	11.00	15.00	8.50	10.50	14.00	7.50	10.50	14.00	7.50
Copper, light and bottoms.....	10.00	14.00	9.00	9.50	13.00	8.00	9.00	12.00	7.00	10.00	13.00	6.50
Lead, heavy.....	4.00	4.75	4.00	4.50	5.00	4.25	4.00	4.50	3.75	4.00	4.25	3.50
Lead, tea.....	3.00	3.75	3.00	3.50	4.00	3.25	3.00	3.50	3.00	3.25	3.00	2.75
Brass, heavy.....	7.00	10.50	7.00	10.50	14.00	10.50	7.00	10.50	14.00	10.50	7.00	10.50
Brass, light.....	5.50	7.50	5.50	7.50	9.50	6.50	5.50	7.50	9.50	6.50	5.50	7.50
No. 1 yellow brass turnings.....	6.50	10.00	5.50	5.50	8.50	12.00	5.50	5.50	8.50	12.00	5.50	5.50
Zinc.....	4.50	5.00	3.00	4.50	5.00	3.00	4.50	5.00	3.00	4.50	5.00	3.00

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by 1/2 in. and larger, and plates 1/2 in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland			Chicago		
	Current	One Month Ago	One Year Ago	Current	One Month Ago	One Year Ago	Current	One Month Ago	One Year Ago
Structural shapes.....	\$3.80	\$4.15	\$3.47	\$3.58	\$3.37	\$3.58	\$3.58	\$3.47	\$3.47
Soft steel bars.....	3.70	4.15	3.37	3.34	3.27	3.48	3.48	3.37	3.37
Soft steel bar shapes.....	3.70	4.15	3.37	3.48	3.27	3.48	3.48	3.37	3.37
Soft steel bands.....	4.65	5.50	4.07	6.25	—	—	—	—	—
Plates, 1/2 to 1 in. thick.....	4.00	4.15	3.67	3.78	3.57	3.78	3.78	3.67	3.67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

BURBANK—The Linoleum & Window Shade Co. is having plans prepared for the construction of three buildings on Vine St. and San Fernando Rd., to include a 12x201-ft. main building, 25x25-ft. warehouse and a 20x30-ft. office building. Cost to exceed \$50,000.

Connecticut

WEST HAVEN (New Haven P. O.)—The Tidewater Oil Corp., Wood St., will build an oil plant to include a 1½-story, 40x100-ft. oil warehouse and storage building and a 1-story, 40x50-ft. garage. Estimated cost, \$25,000. Work will be done by day labor.

Idaho

WEISER—The city plans an election Jan. 4 to vote on \$150,000 bonds to build a water system, including a filtration plant. L. C. Kelsey, Filer, engr.

Illinois

BLOOMINGTON—The city will receive bids in January for the construction of a sewage disposal plant. Estimated cost, \$60,000. Alvord & Burdock, 8 South Dearborn St., Chicago, archts.

CHICAGO—A. M. Castle & Co., 715 North Morgan St., plans to construct an additional warehouse to have 150,000 sq. ft. of floor space. Estimated cost, \$450,000.

Indiana

EVANSVILLE—The Evansville College will receive bids until Jan. 15 for the construction of a 3-story, 70x120-ft. science hall. Estimated cost, \$250,000. Miller, Fullenwider & Dowling, 6 North Michigan Blvd., Chicago, Ill., archts.

FLINT—D. O. Oury, Trustee, Angola, will receive bids in January for the construction of a 2-story, 80x80-ft. school. A sewage disposal plant will be installed in same. Estimated cost, \$75,000. A. H. Ellwood & Son, Elkhart, archts.

GARY—The American Pure Paint Co. is building a 40x100-ft. plant for the manufacture of paint pigment and putty. Estimated cost, \$30,000. W. J. Schroeder, secy.

Iowa

SIOUX CITY—The Zonta Tire & Rubber Co. has awarded the contract for the construction of a 1-story, 100x120-ft. factory, to the Federation Constr. Co.

Louisiana

BASTRUP—L. H. Fox has awarded the contract for the construction of a reduction plant to include three 2-story, 50x200-ft. buildings and four 1-story, 30x60-ft. buildings, to the Widmer Eng. Co., Century Bldg., St. Louis, Mo. Estimated cost, \$200,000.

Maine

ROCKLAND—The Rockland & Rockport Lime Co. will build an addition to its lime plant, to include 6 limekilns and gas producers, 1-story, 35x100-ft. main building and a 2-story, 60x108-ft. lime storage and packing house.

Massachusetts

AMHERST—The Massachusetts Agricultural College plans to build a laboratory building. Estimated cost, \$200,000.

Michigan

HOLLAND—The city is having plans prepared for the construction of a sewage treatment plant. Estimated cost, \$200,000. Greeley, Pearce & Hausen, 39 West Adams St., Chicago, Ill., archts.

RIVER ROUGE—The Bd. Educ., c/o A. R. Heuer, has awarded the contract for the construction of a 3-story high school on Dearborn Rd., to Bryant & Detwiler,

2336 Dime Bank Bldg., Detroit. A chemical laboratory will be installed in same. Estimated cost, \$1,000,000. Noted Nov. 17.

Minnesota

BELLINGHAM—The Bd. Educ. is having plans prepared for the construction of a 2-story, 50x140-ft. high school. A chemical laboratory will be installed in same. Estimated cost, \$80,000. J. L. Mittlestadt, clk.

NEW PRAGUE—The Bd. Educ. plans to build a 2-story high school. A chemical laboratory will be installed in same. Estimated cost, \$85,000. J. Joach, clk.

OWATONNA—The city plans an election Jan. 19 to vote on \$475,000 bonds to construct a gas plant, etc. C. J. Servatins, city clk.

SHERBURNE—The Bd. Educ. plans to build a 2-story high school. A chemical laboratory will be installed in same. Estimated cost, \$85,000. J. Schott, clk.

Missouri

MAPLEWOOD (St. Louis P. O.)—The St. Louis Paper Can & Tube Co., 4400 North Union Ave., St. Louis, has awarded the contract for the construction of a 1-story, 200x540-ft. factory on Big Bend Rd. along the tracks of the Missouri Pacific R.R., to the Widmer Eng. Co., Century Bldg., St. Louis. Estimated cost, \$500,000.

North Carolina

MAIDEN—The town has awarded the contract for the construction of 3 sewage disposal plants, etc., to Boyd, Higgins & Goforth, Charlotte. Estimated cost, \$115,000.

North Dakota

CARRINGTON—The Bd. Educ. is having plans prepared for the construction of a 2-story high school. A chemical laboratory will be installed in same. Estimated cost, \$150,000. E. T. Smith, Supt. Shannon, Boyd & Boyd, Jamestown, archts.

CARRINGTON—C. C. Carnahan, city clk., will receive bids in the spring for the construction of a sewage disposal plant. Estimated cost, \$15,000. L. P. Wolff, 1000 Guardian Life Bldg., St. Paul, engr.

Ohio

PAINESVILLE—The Middle States Rubber Co., c/o E. Ewing, 708 Williamson Bldg., is having plans prepared for the construction of a 2-story, 60x200-ft. factory and warehouse. Estimated cost, \$200,000. Osborn Eng. Co., 2348 Prospect Ave., archt. and engr.

PORTSMOUTH—The Bd. Educ. plans to build a 3-story, 110x130-ft. high school. Laboratory equipment will be installed in same. Estimated cost, \$400,000. A. Pretzinger, 1155 Reibold Bldg., Dayton, archt.

Pennsylvania

CHARLEROI—The Federal Fdry. Supply Co., 2633 East 79th St., Cleveland, O., plans to build a 2-story, 40x92-ft. factory. Estimated cost, \$30,000. J. Bayer, pres.

South Dakota

WATERTOWN—The Bd. Educ. plans to build a 2- or 3-story high school. A chemical laboratory will be installed in same. Estimated cost, \$250,000. A. Herzel, clk.

Utah

SALT LAKE CITY—The School Bd. will soon award the contract for the construction of a 2-story, 68x218-ft. junior high school. Science rooms and chemical equipment will be installed in same. Estimated cost, \$250,000. F. D. Rutherford, 662 Second Ave., archt. and engr.

Virginia

EMPORIA—The Emporia Potassium Phosphate Co. plans to build a fertilizer plant. Carneal & Johnston, Chamber of Commerce Bldg., Richmond, archts.

Wisconsin

CHIPPEWA FALLS—The Bd. Educ. will receive bids about Feb. 1 for the construction of a 2-story, 125x160-ft. addition to

the junior vocational school. A chemical laboratory will be installed in same. Estimated cost, \$150,000. Beers, Schlitz & Bailey, engr.

JANESVILLE—The Bd. Educ. will receive bids in the spring for the superstructure of a 3-story, 180x200-ft. high school, etc. A chemical laboratory will be installed in same. Estimated cost, \$500,000. Van Ryn & DeGeline, Caswell Bldg., Milwaukee, archts. Noted Dec. 15.

Ontario

LONDON—The Bd. Educ., Hydro Offices, is having plans prepared for the construction of three 2-story, 100x220-ft. high school. Equipment for chemistry and physical laboratories will be installed in same. Estimated cost, \$750,000. L. E. Carrothers, Hydro Offices, archt.

Quebec

SOREL—M. J. Danseveau will receive bids in January for the construction of a pulp mill to have a daily capacity of 100 tons of pulp. Estimated cost, \$500,000.

New Publications

THE CHEMICAL FOUNDATION, New York City, has issued a booklet on the "Electrochemical and Electrometallurgical Patents," which are owned by them.

THE COKING INDUSTRY OF THE PACIFIC NORTHWEST. By Joseph Daniels, Bull. 9, Univ. of Washington, Seattle, Wash., Engineering Experiment Station.

THE COMMITTEE ON BIBLIOGRAPHY of the Technical Association of the Pulp and Paper Industry desires to call the attention of the paper industry, and especially those interested in scientific and technical cellulose chemistry, to two new German periodicals which are devoted entirely to cellulose:

Zellulose-Chemie, Wissenschaft Beiblatter zu der Zeitschrift "Der Papierfabrikant."

This periodical, which is issued as a supplement to *Der Papierfabrikant*, is edited by Emil Heuser of Darmstadt. Vol. 1, No. 1, appeared April 30, 1920. It appears at monthly intervals, each number containing from 8 to 12 pages. The scope of the magazine may be seen from the following contents of the first five numbers.

No. 1, April 30, 1920, Advances in Cellulose Chemistry, by Emil Heuser.

No. 2, May 28, 1920, Methylation of Cellulose, by Denham and Woodhouse. (Translation of articles appearing in the *Journal of the Chemical Society*, vol. 103, p. 1,735 (1913); vol. 105, p. 2,357 (1914).)

No. 3, June 18, 1920, Trimethyl Glucose From Cellulose, by Denham and Woodhouse. (Translation from the *Journal of the Chemical Society*, vol. 111, p. 244 (1917). The Estimation of Cellulose in Wood, by W. H. Dore. (Translated from *Paper*, vol. 26, No. 1, p. 10 (1920).)

No. 4, July 16, 1920, The Enrichment of "Kraftstroh," With Fungus Protein, by Pringsheim and Lichtenstein.

No. 5, Aug. 20, 1920, Preparation of Alcohol From Wood, by Emil Heuser. The Constitution of Cellulose; an abstract of the work of Hess, appearing in *Z. Elektrochem.*, 1920, p. 233.

In addition to the major articles, each number contains a number of abstracts of articles from other journals on the subject of cellulose.

Der Papierfabrikant is published by Otto Elsner, Berlin, S. 42, Germany.

Zellstoffchemische Abhandlungen.

This monthly magazine is edited by Carl G. Schawbe of Eberswalde, and is published by Carl Hoffman, Berlin S.W. 11, Germany. The price of the first five numbers of 1920 is 20 marks.

The first number (June, 1920) contains an article by Rudolf Sieber on the determination of the calcium content of fresh sulphide liquors according to Feld-Sander; and also the first part of an article from the laboratory of Ost in Hanover on the acetylotic decomposition products of cellulose, by R. Prosiel. The July number completes the article by Prosiel and contains in addition an article by Schawbe and Ernst Becker on the chemical composition of mechanical wood pulp.

NEW BUREAU OF MINES PUBLICATIONS: Bull. 180, Bibliography of Petroleum and Allied Substances, 1917, by E. H. Burroughs; Bull. 184, The Manufacture of Sulphuric Acid in the United States, by A. E. Well and D. E. Fogg; Tech. Paper 259, Production of Explosives in the United States During the Calendar Year 1919, by William W. Adams.

U. S. TARIFF COMMISSION PUBLICATION: Industrial Readjustments of Certain Mineral Industries Affected by the War.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Ill.

AMERICAN CERAMIC SOCIETY will hold its annual meeting the week of Feb. 21, 1921, at Columbus, Ohio, with headquarters at the Deschler Hotel.

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29, 1921.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting Feb. 14 to 17 in New York City.

AMERICAN PHYSICAL SOCIETY will hold its annual meeting, beginning Dec. 28, at Chicago, it being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

COMMON BRICK MANUFACTURERS' ASSOCIATION OF AMERICA will hold its annual meeting at the Hotel Pennsylvania, New York City, Jan. 31 to Feb. 4.

COMPRESSED GAS MANUFACTURERS' ASSOCIATION will hold its eighth annual meeting, Monday, Jan. 17, 1921, at 2 p.m., at the Hotel Astor, New York, and its eighth annual dinner at the same place that evening.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at the Statler Restaurant, Newark, N. J., the second Monday of every month.

SOCIETY OF CHEMICAL INDUSTRY holds its Perkin Medal Award Meeting at Rumford Hall, Chemists' Club, New York, on Jan. 14, 1921.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: Jan. 7, American Chemical Society; Jan. 14, Society of Chemical Industry, Perkin Medal award; Feb. 11, American Electrochemical Society, joint meeting with Society of Chemical Industry, American Chemical Society and Société de Chimie Industrielle; March 11, American Chemical Society, Nichols Medal award; March 25, Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

Industrial Notes

THE AMERICAN CHAMBER OF COMMERCE in London has just published its year book for 1920, containing the names, addresses and business classifications of over 1,000 American and British firms and individuals interested in developing business between the two countries. The book should be useful in connection with overseas trade and markets.

THE NASHVILLE INDUSTRIAL CORPORATION, composed of business men of Nashville, Tenn., has purchased from the U. S. Government the Old Hickory powder plant at Jacksonville, Tenn., located twelve miles east of Nashville, on the navigable Cumberland River. The purpose of the Nashville people is to industrially develop this immense war undertaking into a large manufacturing center, having available immense housing and manufacturing buildings and facilities. The village had a population of 35,000 when the plant was closed in 1918, and is now completely equipped with all necessary public utilities, schools, banks, clubhouses, etc., and offers many attractive inducements to new industries or those desiring a change in their location. This was the largest Government manufacturing undertaking during the war, costing over \$87,000,000. It occupies 5,100 acres of land, has a water filtration system capable of supplying a city the size of Boston, one of the largest steam power plants in the world, a double-track railroad connecting with trunk lines, thirty-five miles of industrial track connecting manufacturing buildings, an immense refrigeration system, complete water-works, sewerage system, fire departments, concrete and macadam roads. A great quantity of surplus material in the manufacturing area will be dismantled and sold.

THE AMERICAN DRESSER TUNNEL KILNS, INC., has removed its executive, engineering and thermal offices to 1740 East 12th St., Cleveland, O.

THE BARBER-GREENE Co., Aurora, Ill., has recently added to its sales force in St. Louis L. M. Dozier. Mr. Dozier was formerly with the Lakewood Engineering Co.

THE GORDON DRYER CORPORATION, maker of Gordon Atmospheric Driers, has for more than a year been operated in affiliation with Grinnell Co., Providence, R. I., stock control of the Gordon Corp. having been passed to the Grinnell interests in March, 1919. Under the new management the company's business grew rapidly and increased manufacturing facilities were soon required to meet the demand for its products. To secure output it was decided to discontinue the Gordon factory at Bush Terminal, Brooklyn, and last April manufacturing operations were transferred to the Grinnell plant in Providence. The construction of a large plant is now being started in Warren, Ohio.

THE OHIO EXPORT & TRADING Co., with offices in the Standard Parts Bldg., Cleveland, and branch offices in New York and several European centers, has recently organized a department dealing with export and import of chemical machinery, heavy chemicals and miscellaneous finished and semi-finished materials.

AMERICAN STEAM CONVEYOR CORP., Chicago, announce that the J. E. Engineering Sales Co. has been appointed its Connecticut sales agent, with offices at 60 Prospect St., Hartford, Conn.

THE BARTHOLOMEY Co., INC., has let a contract for converting the Genesee Brewery, Rochester, N. Y., into a vegetable oil refinery, using the Brown-Baskerville process. The plant will have a capacity of 50 tons of oil a day. H. E. Brown, New York City, is the engineer.

GROSS, SON & ROBERTSHAW have been appointed sole selling agent for Wild-Barfield electric furnaces for the counties of Northumberland, Durham, Cumberland and Yorkshire. In addition to the office in Newcastle, England, the firm has opened a branch office at 41 Great George St., Leeds, England, where a demonstration furnace is in course of erection. Macbeth Bros. & Co., Ltd., of Bombay and Calcutta, have taken over the sole selling rights for India, where these plants are already in operation.

THE KEWANEE BOILER Co., Kewanee, Ill., held a large celebration on the event of the completion of its million-dollar plant addition on Oct. 20. Many speeches were made by the local city officials and members of the Chamber of Commerce.

THE CUTLER-HAMMER MFG. Co., of Milwaukee and New York, has recently acquired the property at 137th St. and Southern Boulevard, in New York City, as an additional plant for the manufacture of "Thermoplax" and "Pyroplax" molded insulation. The five-story building on this property has been completely equipped with presses for this work. When working at capacity the new plant will have an output equal to the company's insulation plant in Milwaukee, which has been running two shifts, night and day, for the past three years. The New York plant will take care of the company's Eastern business in this line, and will relieve the Milwaukee plant, which is overtaxed in supplying the demand for molded insulation parts. F. J. Boller, formerly of the Milwaukee insulation department, is in charge of the new plant.

FAIRBANKS, MORSE & Co., has purchased the entire business, consisting of all stock on hand, good-will and liabilities, of the Luster Machine Shop & Railway Equipment Co., 917 Arch St., Philadelphia, and has opened a new branch at this address under the management of D. W. Dunn, who will sell the company's complete line of engines, motors, pumps, etc. The entire personnel of the Luster Machinery Co. has been retained. E. J. Luster, former president, will be manager of the machine tool division of the Fairbanks-Morse Philadelphia branch.

CHICAGO BRIDGE & IRON WORKS, Chicago, Ill., announces the opening of a new sales office at Atlanta, Ga., in the Forsythe Bldg. Joseph L. Zeller, who has been with this company for a few years, will be in charge and have the territory including the states of Georgia, Alabama, Tennessee and Florida.

THE CEMENT GUN Co., INC., announces new Report on Tests of Gunite Slabs, which gives working tables and safe load tables, established through tests. The company also announces the removal of its main office from Allentown, Pa., to Cornwells, Bucks Co., Pa.

SAMUEL LEDERER has purchased the plant of the Hammond Brewing Co., West Ham-

mond, Ill., which will be put into operation for the manufacture of beverages.

MORSE CHAIN Co., Ithaca, N. Y., has established a Detroit branch factory, which will be devoted exclusively to the manufacture of silent chain sprockets and the Morse adjustment. The Morse Chain Co. will continue to manufacture chains and power transmission at the main plant at Ithaca. The Detroit branch will be under the general management of F. C. Thompson, with F. M. Hawley as chief engineer and C. B. Mitchell as factory manager. Sales and engineering offices are located at the Detroit plant, corner of Eighth and Abbott Streets. The Detroit plant has been added to partly relieve the Ithaca plant. Since the first buildings were erected at Ithaca in 1907 this company has been continuously adding new buildings; in fact, there are now three large construction gangs at work on two large new concrete buildings, making considerable addition to the 7 acres of floor space now under roof as well as another concrete stack 185 ft. high providing for additional power plant equipment. This company also announces that the Morse Chain Gang is always studying and looking for improved and more efficient machines, tools, and equipment, and would appreciate receiving the latest in catalogs, booklets and circulars.

THE CHICAGO PNEUMATIC TOOL Co. announces the removal of its rock drill plant from 864 East 72nd St., Cleveland, O., to the company's Boyer pneumatic hammer plant at 1301 Second Blvd., Detroit, Mich. Location of the company's Little Giant air drill plant at 1241 East 49th St., Cleveland, remains unchanged.

HUGO ZELLER announces that he has resigned as president, treasurer and general manager of the Egyptian Lacquer Mfg. Co., having offices at 5 East 40th St., New York City. Richard Zeller and Gustav Zeller, his brothers, who were also connected with the Egyptian Lacquer Mfg. Co. in the manufacturing end, occupying positions respectively of vice-president, secretary and plant managers and assistant secretary and assistant plant manager, have also resigned from this concern. The three brothers Zeller will continue to be identified together and announcement regarding their plans will be issued in the near future.

THE CHAIN BELT Co., Milwaukee, Wis., announces that Clifford F. Messinger has been appointed general sales manager to succeed L. C. Wilson, who has resigned to become secretary of the Federal Malleable Co., closely associated with the Chain Belt Co. Other promotions announced are C. E. Stone, assistant to the vice-president, and J. A. Monahan, purchasing agent. Mr. Messinger, for the last two years assistant to the vice-president, is a Yale graduate and has been connected with the Chain Belt Co. since 1911. He is perhaps best known in his capacity as manager of Rex Mixer Sales, which he held for three years, and has also been advertising manager. Recently Mr. Messinger has been elected chairman of a group of nationally known construction machinery manufacturers associated for the purpose of developing export business.

ALBERT H. HOPKINS has resigned from the presidency of the Engineering Advertisers' Association of Chicago and from the managership of advertising and sales promotion departments of the C. F. Pease Co., Chicago, to become Chicago manager for the J. Roland Kay Co., international advertising agents, at their new building at 161 East Erie St., just east of North Michigan Boulevard. Mr. Hopkins is known through the Middle West as a former publishers' special representative and through his activities as an organizer and charter member of the above association. His association with the J. Roland Kay Co. will also be in the capacity of manager of its domestic division.

THE TEXAS PORTLAND CEMENT Co., Dallas, Tex., in line with the policy to keep its mills thoroughly modernized and to adequately provide cement for its trade, and which has recently doubled the capacity of its Houston mill, now announces that plans are prepared and work has actually started on the installation at its Dallas mill of one 9x200-ft. kiln, together with additional raw mill machinery and other construction necessary for the increased output.

E. F. HOUGHTON & Co., Philadelphia, announce that George H. Morgan has been elected treasurer. The position of secretary, formerly held by Mr. Morgan, has been filled by the election by the board of directors of George W. Pressell, chief of the Houghton research staff. Mr. Morgan will retain the position of managing director of the leather manufacturing department.